IN THE UNITED STATES DISTRICT COURT
MIDDLE DISTRICT OF NORTH CAROLINA

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| COMMON CAUSE, et al.,<br><br>Plaintiffs,<br>v.<br><br>ROBERT A. RUCHO, in his official capacity as Chairman of the North Carolina Senate Redistricting Committee for the 2016 Extra Session and Co-Chairman of the Joint Select Committee on Congressional Redistricting, et al.,<br><br>Defendants.<br><br>LEAGUE OF WOMEN VOTERS OF NORTH CAROLINA, WILLIAM COLLINS, ELLIOTT FELDMAN, CAROL FAULKNER FOX, ANNETTE LOVE, MARIA PALMER, GUNTHER PECK, ERSLA PHELPS, JOHN QUINN, III, AARON SARVER, JANIE SMITH SUMPTER, ELIZABETH TORRES EVANS, and WILLIS WILLIAMS,<br><br>Plaintiffs,<br>v.<br><br>ROBERT A. RUCHO, in his official capacity as Chairman of the North Carolina Senate Redistricting Committee for the 2016 Extra Session and Co-Chairman of the 2016 Joint Select Committee on Congressional Redistricting,<br><br>DAVID R. LEWIS, in his official capacity as Chairman of the North Carolina House of Representatives Redistricting Committee for the 2016 Extra Session and Co-Chairman of the | Greensboro, North Carolina<br>October 16, 2017<br><br>Case No. 1:16CV1026<br><br>Bench Trial<br><br>Volume I of IV<br><br>Case No. 1:16CV1164 |

2016 Joint Select Committee on Congressional Redistricting, )
)
TIMOTHY K. MOORE, in his official capacity as Speaker of the North Carolina House of Representatives, )
)
PHILIP E. BERGER, in his official capacity as President Pro Tempore of the North Carolina Senate, )
)
A. GRANT WHITNEY, JR., in his official capacity as Chairman and Acting on Behalf of the North Carolina State Board of Elections, )
)
THE NORTH CAROLINA STATE BOARD OF ELECTIONS, and THE STATE OF NORTH CAROLINA, )
)
Defendants. )
_____)

PROCEEDINGS HELD BEFORE:

**WILLIAM L. OSTEEN, JR.,**
CHIEF U.S. DISTRICT JUDGE FOR THE MIDDLE DISTRICT OF N.C.

**W. EARL BRITT**
SENIOR U.S. DISTRICT JUDGE FOR THE EASTERN DISTRICT OF N.C.

**JAMES A. WYNN, JR.**
CIRCUIT JUDGE OF THE U.S. COURT OF APPEALS FOR THE 4TH CIRCUIT

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I N D E X


| WITNESSES FOR THE PLAINTIFF: | PAGE |
|---|---|
| JONATHAN CHRISTOPHER MATTINGLY | |
| Direct Examination By Mr. Epstein | 20 |
| Cross-Examination By Mr. Strach | 93 |
| Redirect Examination By Mr. Epstein | 129 |
| Recross-Examination By Mr. Strach | 141 |
| JOWEI CHEN | |
| Direct Examination By Mr. Thorpe | 153 |
| Cross-Examination By Mr. Strach | 216 |

| EXHIBITS: | | RCVD |
|---|---|---|
| PX-3040 | Dr. Mattingly PowerPoint presentation demonstrative | 75 |
| PX-3041 | Chen Illustrative Exhibit | 162 |

P R O C E E D I N G S

(At 9:05 a.m., proceedings commenced.)

JUDGE OSTEEN: All right. Good morning, everyone. Apparently, Judge Wynn was sitting in my chair earlier this morning and lowered it down on me.

Calling now for trial cases number -- Case Numbers 16CV1026 and 16CV1164. 1026 is Common Cause, et al., versus Rucho, et al., and 1164 is League of Women Voters versus Rucho, et al.

Let's see. Why don't we start with the Common Cause Plaintiffs. Are you all ready to proceed?

MR. SPEAS: We are, Your Honor.

JUDGE OSTEEN: And if you'll just introduce Common Cause attorneys you have seated at the table.

MR. SPEAS: Seated to my right is Emmet Bondurant, and to his right is Peter Nelson. Mr. Bondurant is with Bondurant Mixson in Atlanta, and Mr. Nelson is with Patterson Belknap in New York. Over here, I have my colleagues Steve Epstein and Caroline Mackie and Ben Thorpe, who is Mr. Bondurant's cocounsel.

JUDGE OSTEEN: All right. Thank you, sir. And for the League of Women Voters?

MS. EARLS: Good morning, Your Honor, Anita Earls, for the League of Women Voters. With me is Allison Riggs of the Southern Coalition for Social Justice, and then Annabelle

Harless from the Campaign Legal Center. Also with our team is Ruth Greenwood from the Campaign Legal Center and Nick Stephanopoulos.

JUDGE OSTEEN: All right. Thank you. And are the Defendants ready to proceed?

MR. STRACH: Yes, Your Honor, thank you, Phil Strach, Ogletree Deakins, here for the Legislative Defendants here with my colleagues Michael McKnight to my left and Brodie Erwin on the far end of the table.

THE COURT: All right. For the State?

MS. PETERS: Good morning, Your Honor, Alec Peters of the Attorney General's Office, along with James Bernier of our office on behalf of the State and the State Board of Elections Defendants.

JUDGE OSTEEN: All right. A couple of things I want to talk about before we get started. First of all, the parties filed their opening statements. I can't speak for all the judges on the bench, but I thought it was very helpful to have those written opening statements filed on Friday to give us a chance to review and see where things were headed. We have also received your deposition designations and exhibit list.

A couple of housekeeping matters: One, in terms of the motion in limine to bifurcate the expert witnesses' testimony with respect to the -- we'll call it the additional theory presented by the League of Women Voters, with respect to

that expert testimony, that motion will be granted. We do ask that you deal with whatever -- address whatever you can during the initial testimony and not be repetitive when you come back. So you're reserving your right to recall the witness to explain a theory based upon certain evidence that will be presented as a foundation during the presentation of your case. So that's one housekeeping matter.

Number two, in reviewing the opening statements, the deposition testimony, and various other evidentiary filings in this case, it appears to me certainly, and to my colleagues as well, that this case is really more about a legal issue than it is a factual issue. In other words, certain facts and evidence will have to be presented in terms of expert testimony as well as perhaps some nonexpert testimony to address the question of whether or not political gerrymander -- well, let's say it this way: Whether or not a justiciable standard can be created to determine whether or not there exists constitutional limits to political and incumbent gerrymandering.

I have no doubt after reading the facts that the Plaintiffs in this -- both of these cases, actually, claim to be aggrieved by the fact generally, I'll summarize it, that based on the percentage of registered Democratic voters and based on the percentage of Republican representatives from the 13 congressional districts, that those voters contend that the political gerrymandering that took place elevated -- unfairly

elevated control of the House races or the congressional races to the Republicans. I'm not stating that as a fact. I'm simply saying that is an issue in the case.

The Supreme Court has been wrestling and is currently wrestling with the question of whether or not political -- whether or not a justiciable standard for political gerrymandering can be established within the context of the United States Constitution.

If, in fact, our analysis is correct, and, that is, this is primarily a legal issue in terms of, A, whether or not a standard can be established, and, B, what standard can be proved by a preponderance of the evidence in this case, then it seems to us that there ought to be some way to streamline this testimony such that we spend more time in final arguments with questions and answers from the Court than we do worrying about -- and I don't mean to diminish this in any way. I'm speaking solely for myself -- than we worry about voters, registered Democrat or otherwise, who are -- contend to have been injured by the election results, most recent on 10/3, if that makes any sense to anyone.

So I'm hoping that perhaps by making these comments here before we start, either the next few minutes this morning, we can take a short break and may take a short break to let you start talking about this, but perhaps we can find some way to really get to the heart of the issues in this case, which

clearly are going to be the expert witness testimony, part one; but, part two, with respect to the facts necessary to establish a foundation for that testimony, it seems to me there's a way that -- whether they're stipulated to or not, that that part can be presented and then some of the -- what we anticipate might be the testimony in the case can either be stipulated to or presented by way of deposition.

Mr. Speas, any questions about those comments at this point?

MR. SPEAS: No, Your Honor, I just --

JUDGE WYNN: Before you start, I want to be clear in terms of where we're going with this. This is primarily a legal case. The issues that are before this Court, rather, are not as simply stated as what is here. They are very difficult legal issues. There's a lot of dispute in terms of what the law is. There's not a lot of dispute in terms of some of the facts in this case. What we want you to do is to stipulate either by stipulation or by deposition, or whatever is there, as to that testimony that there's no dispute. We don't want to hear undisputed evidence because we can read, and so that's basically where we're going, so if we can go there.

And then we want to give you ample time to present the legal arguments to this Court, because that's really where it is. We don't want to hear the policy arguments and all the other stuff that goes with it in terms of what might sound good

because this is a legal case, and we want to get to the law of the case quicker.

MR. SPEAS: We agree with you, Your Honors, that this is a case in which there is not significant dispute as to the facts. We would like the opportunity to put on Senator Dan Blue to give the Court an overview of what happened in the legislature because we think that is important. We also would like to put on our two institutional Plaintiff representatives, Bob Phillips from Common Cause and Wayne Goodwin from the Department -- from the Democratic Party, but we have our two experts here today.

My estimate is that we can present this evidence to the Court within the day. We would be happy to confer, of course, with the other side about further stipulations, but we have tried to tailor our case to just what you're saying. This is, in essence, a legal dispute about which the facts are not much in dispute. I suppose they have an expert who has one view. We certainly have experts who have a different view, but with regard to what happened in the General Assembly, most of it is transcribed and recorded and before the Court in stipulated exhibits.

JUDGE WYNN: Mr. Speas, we want you to present your case. What I'm saying to you is do not present that which we are reading. If we are reading it and we see it, I don't need for a witness -- if it can be stipulated to, if the other side

agrees with you, this is what he's going to say, we don't have any dispute with it, streamline it, and I understand you want to get it out, but understand the Court already has read this, and we're the Court. This is not a public trial in the sense that you're trying to appeal to a jury. We have already read this. So streamline it. I know you feel like you've got to say it, but you don't have to keep repeating it to us if we read it. That's the only thing I'm saying, and I think you are going to have to have time to confer with counsel. If you can't agree, present it.

JUDGE OSTEEN: Let me get Ms. Earls -- if she has anything, and then we'll come around to you.

MS. EARLS: Yes, Your Honors, I appreciate and understand the point you're making. I would say this immediately arises for us in the -- with the first witness because there's an exhibit that hasn't been stipulated to, the videotape of actual legislative proceedings. So that immediately comes to fore for us, but I would just add the other point, that the question of standing has been contested by the Defendants as well, and that's what some of our individual Plaintiffs were intending to address, the facts that we contend show they have standing.

So that's another issue that if there was a stipulation, we wouldn't have to present testimony, but if it's contested, then we have facts that relate to standing.

JUDGE WYNN: Well, I think the facts, to the extent that they are presented, if they're undisputed, we will make the decision on standing on law, but we don't need to hear facts that we already -- that you can stipulate to.

MS. EARLS: Thank you, Your Honor.

MR. STRACH: Your Honor, I agree with that. Many of the facts on standing, et cetera, are in the transcripts that have already been filed, and we would certainly be happy -- if the Court wanted to give the parties a brief recess, we -- from the defense side, we certainly would be willing to have this conversation right now before the Court got going, in light of the comments we're hearing.

JUDGE OSTEEN: All right.

MS. PETERS: Nothing to add to that, Your Honor.

JUDGE OSTEEN: All right. Why don't we take a little 15-minute recess now and let you all talk a little bit.

I'm well aware of the fact -- or I'm assuming, I'm not well aware of, that you may have been swapping witness lists to prepare for each day ahead, and we'll make some allowances if things change and we need some stuff; but we'll give you 15 minutes now, and just do the best you can with it. We'll come back, we'll start hearing the evidence, and then once we've -- we'll get through to at least the lunch break, and if at various points you think about stopping and stipulating or doing whatever, we'll give you some time as we

go ahead.

I understand we're springing this on you a little bit, but we got the opening statements on Friday. We've had the benefit of the proposed findings and conclusions of law. So we have some idea of what the -- what the issues are in the case, and I agree with Judge Wynn 100 percent in terms of primary legal issues that are going to have to be resolved and complicated legal issues. I don't mean to diminish that in any way, but you all know best what evidence is necessary to decide those issues.

We'll stand in recess for 15 minutes.

(At 9:18 a.m., break taken.)

(At 9:42 a.m., break concluded.)

JUDGE OSTEEN: Just so everybody knows, we'll do an official opening and closing at the beginning of the day and at the end of the day, and on recesses and lunches, we'll just come back in and get started. You'll hear a law clerk say remain seated, come to order, the court is again in session.

Judge Britt, I think you wanted to admonish the parties before we get started.

JUDGE BRITT: Not exactly. I just want to ask for your cooperation. When you get to my age, some artificial equipment helps you considerably, and for me, it's my hearing aids; and my hearing aids, fortunately, through Bluetooth technology, are tied in with the sound system here. We've just

been able to get it working right. So if you will, please try to talk into the microphone, although not too close to it; but, most importantly, please try to avoid letting a sheath of papers hit that microphone because it's painful. Thank you very much.

JUDGE OSTEEN: All right. We've got the courtroom set up a little differently from last time. The witness box obviously is turned, so we, as the finders of facts, can have a better view of the witnesses. We'll see how it goes. I would like you to conduct your examinations from the podium to the extent possible because it allows the witness to look this way instead of having to look away from us.

We're ready to proceed. The Plaintiffs may call their first witness.

MR. SPEAS: Your Honor, I think that we have reached an agreement. I would like to outline that agreement and make sure that I'm stating it correctly.

The agreement is that all depositions and all deposition exhibits come in the record. All objections previously made to any testimony or any exhibit is withdrawn. The live testimony will be limited to the expert witnesses.

Mr. Strach has agreed that I can take five minutes and put the case in context, and he will tell the Court whether I have misstated it or not and that Mr. Earls will take a short time and do the same thing, and Mr. Strach will sign off or

not.

JUDGE OSTEEN: All right. So, basically, a mini opening statement kind of thing, an outline of what's going on?

MR. SPEAS: I wouldn't go so far as to describe it that way, but, yes, just putting it briefly in context.

JUDGE OSTEEN: All right. Everybody good with that?

JUDGE BRITT: Absolutely.

JUDGE OSTEEN: All right. You may proceed then. I don't want to get too far out of order, but we'll recognize the stipulation, and all depositions and exhibits are admitted.

MR. SPEAS: And if, at this point, I may make my very brief remarks putting the case in context.

JUDGE OSTEEN: You may.

MR. SPEAS: On February 5, 2016, the federal court declared the 2011 Congressional Redistricting Plan unconstitutional because Districts 1 and 12 were racial gerrymanders for which there was no compelling interest. The Court gave the legislature until February 19 to draw a new map.

On the 12th of February, a redistricting committee was appointed by the speaker and the president of the Senate. Senator Rucho and Representative Lewis were cochairs. Thirty-six persons were appointed to the committee, 24 Republicans and 12 Democrats.

On Monday, February 15, the Joint Committee appointed on Friday convened to hold a public hearing. The transcript of

that public hearing is Exhibit 1004. The next day, Tuesday, February 16, the Joint Committee met to adopt the criteria to be used to draw the new map. One of those criterion was partisan advantage, which reads: "The political makeup of the Congressional Delegation is ten Republicans and three Democrats. The Committee shall make reasonable efforts to construct districts in the 2016 Plan to maintain the current partisan makeup of the North Carolina Congressional Delegation."

Another criterion presented to the committee on that date was -- well, let me back up just a second. Representative Lewis was asked to explain that criterion on the floor. He said, and I quote: "The explanation of this is reasonably simple, as we are allowed to use political data in the drawing of maps. I would propose that to the extent possible the map drawers create a map which is likely to elect ten Republicans and three Democrats. I acknowledge freely that this would be a political gerrymander, which is not against the law."

In response to a question from Senator McKissick, at that meeting, Representative Lewis said, and I quote: "I propose that we draw the maps to give a partisan advantage, ten Republicans and three Democrats, because I do not believe it is possible to draw a map with eleven Republicans and two Democrats."

The 2016 elections were held, and three -- ten

Republicans and three Democrats were elected.

With regard to the political data criterion, Representative Lewis said on February 16 that "We want to make clear that to the extent we are going to use political data in drawing the map, it is to gain partisan advantage, advantage on the map. I want that criterion to be clearly stated and understood."

MR. STRACH: Your Honor, those are certainly facts in the legislative record. Just brief additional context is that the two criteria that Mr. Speas has related to the Court were among four or five or six other criteria, all of which, the record will show, were followed and balanced and harmonized. It was not simply -- partisan advantage was not the only criterion that was followed.

And I will simply just note for the Court that the statements by Representative Lewis that Mr. Speas has noted have all been explained in his deposition. They'll be coming in. The Court will be able to see that the explanation for those is that Representative Lewis was making it clear that since they were -- had been -- the districts had been ruled a racial gerrymander, that the political data was in no way being used to further any race goals, but that there's different motives at play.

And so this is -- the Court will see when it reads the record that this was a uniquely -- a unique case in that it

was coming back on a draw from racially gerrymandered districts, and that largely explains the mistakes.

JUDGE OSTEEN: All right.

MR. SPEAS: Your Honor, just to be clear, we would suggest that the deposition transcripts don't explain it.

JUDGE OSTEEN: Understood.

MS. EARLS: Your Honor, if I may be heard briefly, I do not need to elaborate further on the factual context, but I do want to be a little more precise on the League of Women Voters' understanding of the agreement that we've reached so far, that it would be fact witness depositions, not all depositions, so not depositions of expert witnesses, and that the -- that there will likely need to be additional fact stipulations relating to standing that we have not fully ironed out with the Defendants, but we're confident that with additional time to discuss, we can likely resolve those.

But I just wanted to be clear it was only the fact witness depositions, and there may be -- the League of Women Voters reserve at this point the potential that there are some exhibits to some depositions or some exhibits that we still need to discuss with the Defendants in terms of whether we would totally agree to their admission.

So the blanket "all depositions, all exhibits" was not quite where we were with the League.

JUDGE OSTEEN: All right. Anything in terms of --

MR. SPEAS: I had understood that the expert depositions were -- the experts will testify, and to the extent their exhibits come in, they come in.

JUDGE OSTEEN: That's the way I understood it, too. Anything further in terms of the facts that you wanted to outline or just overview of the agreement?

MS. EARLS: I only wanted to address the agreements.

JUDGE OSTEEN: All right. Mr. Strach?

MR. STRACH: Your Honor, I believe that's largely right, although I think we and the Common Cause Plaintiffs were probably more in agreement that everything will come in from fact witnesses regardless. I think we're prepared to waive all objections.

The only logistical issue that I've already raised with the Plaintiffs and I wanted to raise with the Court is we were assuming our case was going to largely be Wednesday and Thursday, and so we have -- one of our experts is currently under subpoena in a case in Arizona, and he won't be able to be here until Thursday. We could have him right up Thursday morning, but he will literally be flying during part of this trial, and we have -- our other expert is -- will probably get here late, late Tuesday night. We could probably put him up Wednesday, but it might be the afternoon. So we may ask the Courts' indulgence and the parties' indulgence, if this moves along more quickly because of our agreements, to help us with

the logistics with some of our experts.

JUDGE OSTEEN: I'll see what the other judges want to do, but from my perspective, if we run into a problem where evidence ends early and we have some gaps in getting witnesses here, my preference would be not to piecemeal it, in other words, not two hours on Wednesday and two hours on Thursday. I would like to try to keep it all in big blocks of time. So if we run out of evidence and we need to discuss it a little bit, I'll just tell you now, I'll be looking to try to get everybody lined up in one day. So if your last witness is here Thursday, get everybody on -- we'll see where we go.

MR. STRACH: That's fine, Your Honor.

JUDGE OSTEEN: That's from my perspective. They're the visitors, and I'll defer to them ultimately.

MR. STRACH: Thank you, Your Honor. That's all we have.

JUDGE OSTEEN: All right. Then you may proceed.

MR. EPSTEIN: Your Honors, at this time the Common Cause Plaintiffs call Dr. Jonathan Mattingly.

(Witness sworn by the clerk.)

JONATHAN CHRISTOPHER MATTINGLY,

PLAINTIFFS' WITNESS, SWORN AT 9:54 a.m.

DIRECT EXAMINATION

BY MR. EPSTEIN:

Q Good morning.

A Good morning.
Q Go ahead and state your full name, please.
A Jonathan Christopher Mattingly.
Q Where did you grow up, Dr. Mattingly?
A Charlotte, North Carolina.
Q Tell us, if you would about your educational --
JUDGE OSTEEN: Hold on just a second.
JUDGE BRITT: Mr. Court Reporter, you're using the wrong lawyer. This is Mr. Epstein instead of Mr. Bondurant.
MR. EPSTEIN: Thank you, Your Honor.
BY MR. EPSTEIN:
Q You may proceed to tell us, if you would, about your education from high school until you completed your education and letting us know along the way what degrees you obtained.
A I started high school in Charlotte, and then I moved to the North Carolina School of Science and Math in Durham; after which, I went to undergraduate at Yale, where I received a degree in applied mathematics. After that, I spent some time in France studying at the Ecole Normale school of nonlinear physics. Then I returned to Princeton University, where I completed my Ph.D in applied and computational mathematics.
Q Now, if you would, take us through your career in teaching from the time it commenced until today.
A After Princeton, I spent four years as a Szego assistant professor at Stanford University in the mathematics department.

Then I spent one year at the Institute for Advanced Study in Princeton, a think tank there, doing research.
Q Let me stop you quickly. Can you name any famous people who went to that think tank like you did?
A Von Neumann and Einstein.
Q Go ahead.
A And then I started my tenure-track position at Duke University, and I progressed there through different ranks, and now I'm a full professor, and, currently, I'm chair of the mathematics department, and I also have an appointment in the statistical science department.
Q What courses have you taught there recently?
A Undergraduate probability, stochastic processes, stochastic computation classes.
Q How many publications have you authored in peer-reviewed professional journals?
A Over 50.
Q Okay.
MR. EPSTEIN: And, Your Honors, at this time I would like to approach the witness, if I may, to hand him an exhibit notebook. I believe the exhibit notebook for him has been placed on the bench for each of Your Honors.
JUDGE OSTEEN: All right. And I don't have any objection to you not asking each time you want to go up.
MR. EPSTEIN: Thank you, Your Honor.

BY MR. EPSTEIN:
Q If you would please turn to the tab marked No. 1, and tell us what we see there.
A It's my CV.
Q Okay. And is your CV something that at the time your expert report was submitted in March of 2017 -- is it accurate as of that date?
A Yes, it is.
Q And does it accurately describe the progression of your education and career and disclosed all of your published writings as of that day?
A Yes.
Q All right. Let's put that aside for a second, and let's talk a little bit about some of these terms that you've used that may be a little bit unfamiliar to us.
What is applied computational mathematics?
A It's the study of mathematics to solve problems of engineering and scientific and social relevance.
Q And what would you consider your area of specialization to be within the field of applied computational mathematics?
A Stochastic processes.
Q Spell that for the benefit of the court reporter.
A Okay. I'm borderline dyslexic, so you'll have to bear with me if I switch letters, S-T-O-C-H-A-S-T-I-C.
Q Okay. Now, that was the hard part. The easy part, what

does it mean?
A It's the Greek word for random. So it just means the study of things that evolve in time or have random influences.
Q Can you give us some examples of how you have used applied computational mathematics to study various phenomenon?
A So I've studied turbulent fluid flow like around a jet wing or in water. I've studied the computational methods that are used to simulate protein folding in, for instance, drug or molecular design. I've also studied biochemical pathways in cells and how they fluctuate, as well as doing some basic understanding of computational methods used in statistics and machine learning.
MR. EPSTEIN: Your Honors, at this point the Common Cause Plaintiffs tender Dr. Jonathan Mattingly as an expert witness in the field of applied computational mathematics.
JUDGE OSTEEN: Voir dire?
MR. STRACH: No objection, Your Honor.
MS. PETERS: No objection, Your Honor.
JUDGE OSTEEN: Mr. Strach, you'll be speaking for all the Defendants primarily? I don't want to catch anybody off guard.
MR. STRACH: Primary, but we'll certainly let you know, but primarily.
JUDGE OSTEEN: Dr. Mattingly is accepted as an expert in the field of applied computational mathematics -- what was

it?

MR. EPSTEIN: That's it. Thank you, Your Honor.

JUDGE OSTEEN: Okay. He may offer his opinion.

BY MR. EPSTEIN:

Q Dr. Mattingly, can you tell us -- we talked about schedules a second ago with witnesses from the Defendant.

Can you tell us if there were any difficulties getting you scheduled to testify this week?

A Yes.

Q What else do you have on your agenda this week?

A Tomorrow, I'm talking to a meeting at the National Academy of Science in Durham on redistricting, and then I'm flying to Toronto for a Fields Medal Symposium in Toronto at the Fields Institute.

Q A Fields Medal Symposium. What's the Fields Medal?

A The Fields Medal is the closest thing to a Noble Prize in mathematics, and a coauthor of mine received it, and I'm talking in celebration and honor of his work.

Q Now, in the 20 or so years that you have been teaching applied mathematics, both at Stanford and at Duke, how many times prior to 2016 have lawyers knocked on your door to ask you to help them in a court case?

A Never.

Q This is the first such case?

A Yes.

Q You've never been an expert witness who testified under oath before this case?
A No, I haven't.
Q How many political science degrees do you have?
A None.
Q Have you ever worked with or for a legislative body in the redistricting process?
A I have not.
Q Describe how you went from being a Duke professor, teaching applied computational mathematics, to sitting here today telling us about redistricting as an expert witness in a court case.
A I had an undergraduate student who became interested in modeling, random modeling of politics through the work of Nate Silver that we all read about in *The New York Times*, and we were reading about that; and then in the popular press, we read about the 2012 election, where just over 50 percent of the votes were cast for Democratic candidates, but, yet, the majority of -- the vast majority elected to the US House of Representatives from North Carolina were Republican, and we started -- we just posed ourselves a question to try to understand what was going on there.
Q Okay. And what was that question?
A Well, some people in the press were arguing that just because 50 percent of the votes had been cast for Democrats,

clearly 50 percent of the representatives should have been Democratic, but, as was already said, I grew up in North Carolina, so I have some idea of the political differences from one corner of the state to the other corner of the state, from different metropolitan areas to other metropolitan areas, and it's quite reasonable that maybe the geopolitical structure of North Carolina could account for some of that.

Q All right. Did you and Ms. Vaughn collaborate on a project in 2013?

A We did.

Q Can you describe that project for the Court?

A We created an ensemble of maps. We generated with computers some maps, and then we reran the elections using the 2012 votes, and we tried this -- we saw what the outcomes were, and we used that to situate the outcomes that actually occurred using the General Assembly's maps.

Q Let's make this as clear as we can for the benefit of the Court.

From the point of time that work began in 2013 until today, has your work, or the work that you assisted students with, ever focused on how a legislative body, be it the North Carolina General Assembly or another, should draw a redistricting map?

A No, we always looked at maps after the fact and tried to situate them and analyze them.

Q And did the work that you and Ms. Vaughn did together eventual lead to looking at congressional redistricting in other states besides North Carolina, such as Maryland and Iowa?
A Yes, there was a second group of people who Christy helped mentor, and that group of undergraduates, again, looked at redistricting in Maryland, in Iowa, in Texas, and a few other states.
Q And did that particulars project have a name?
A Yes, that was called the Quantifying Gerrymandering Project.
Q Now, did there come a point in time when the Terry Sanford School of Public Policy at Duke became interested in the work that you and Ms. Vaughn and you and this other group of students had been doing on redistricting?
A Yes. So Tom Ross was in residence as a visiting professor at Duke University in the Terry Sanford School of Public Policy, and he had approached Information Initiative, which is a group that deals with large data, to maybe provide some technical support and some analysis of his -- in his project.
Q And is that the Tom Ross that was the president of the UNC system before going to Duke as a visiting professor?
A Yes, and Davidson.
Q And when was that that he began talking to you about this project?
A That was spring of 2016.

Q Okay. What was the project that he envisioned at its inception?
A It was a simulation of a bipartisan redistricting committee where it would be made up of retired judges, and they would make up their own maps following -- House Bill 92 was what he was setting out as his procedure.
Q And we'll talk about that bill in a minute, but how was that -- how were the judges divided? Was there some kind of partisan divide on that -- on that pretend or fictional committee of a redistricting commission?
A He called it a simulation of a redistricting committee, and it was six Democrats and six Republicans.
Q Okay. And did that project have a name?
A Yes, it was Beyond Gerrymandering.
Q And did you and another group of students get involved in the Beyond Gerrymandering Project?
A Yes.
Q In what time frame?
A That was over the summer of 2016 and into the fall.
Q And what role did you and your students play in the Beyond Gerrymandering Project?
A We observed mainly the judges' deliberations, and then once they had produced their maps, they were given to us; and we then tried to situate them, much as we had done before, using an analysis of, you know, a group of other maps that we

generated, how typical and the characteristics of those maps, and then we gave a report on it.
Q All right. And you said maps in plural. I just want to make sure we're clear. Did the Beyond Gerrymandering Project produce multiple maps for the congressional redistricting or just one?
A A single map.
Q Okay. And did all of that occur before you became involved in this case?
A Yes.
Q All right. Well, let's talk about your involvement in this case. When and how were you asked to become involved in this case?
A Based on some of the presentations we've given, Eddie Speas approached me around Christmas of 2016.
Q Okay. And when he approached you, what did he ask you?
A He asked if we would be -- if I would be willing to write up a report which summarized the work we had done already.
Q How far along was the work you were doing on the project for Tom Ross, the Beyond Gerrymandering Project, at the time that Mr. Speas approached you around Christmas of 2016?
A The main conclusions we'd already presented in a conference at the Sanford School, and we were in the process of writing up a report.
Q And having never been an expert witness in a case before,

did you run for the hills or did you sign on?
A You should always try everything once, right? So, yes, we signed on.
Q Okay. And what specifically did Mr. Speas ask you to do?
A He asked just to write out a report that summarized what results we had presented in our talk and what we had found in analyzing the judges maps and how that fit into the maps that the legislature had drawn.
Q Did he ask you to do that work for free?
A No.
Q Did he talk with you about compensation?
A Yes.
Q And what was discussed about compensation?
A $12,500.
Q $12,500 a week? A month? A year?
A A flat fee.
Q Dr. Mattingly, about how many hours have you put into your efforts as an expert witness in this case?
A Hundreds.
Q Does that include preparation of your report, your deposition -- which occurred over two days, is that right?
A Yes.
Q -- your preparation for trial and your time here at trial?
A That is correct.
Q And since you began your involvement in this case, have

you also provided assistance in other court cases involving redistricting and alleged gerrymandering?
A Yes, we did some more analysis, again as an academic analysis. We did analysis of the redistrictings in Wisconsin, and then we were -- became involved with writing an amicus brief to the Supreme Court based on that analysis, and then right after the legislature released its new maps for the North Carolina legislative maps, the Senate maps, we were involved in making some preliminary analysis and filing a summary of that report for Common Cause.
Q Okay. Did you get paid for either of those efforts?
A The first one, no. The amicus brief was just a summary of a paper we had written, which is now publicly available, and the second one, a member of my team was paid; I was not.
Q All right.
A Because he did the writing.
Q Now, Dr. Mattingly, you've talked about Mr. Speas asking you to write a report in this case, an expert report. Did you, in fact, eventually do that?
A I did.
Q All right. If you would open your witness notebook, just so it's clear to the Court, behind Tab No. 2, labeled "Plaintiffs' Exhibit No. 3002," is that your report for this Court in this case?
A It is.

Q Entitled "Report on Redistricting, Drawing the Line," Jonathan C. Mattingly?
A Yes.
Q And that was submitted back in March?
A Yes.
Q Was the content of that report something that you prepared solely for the lawyers that are assembled here today?
A No. Since we already had a draft of our actual academic paper in progress, I borrowed heavily from that.
Q Okay. Is there a more complete version of the information contained in your expert report in this case?
A Yes.
Q And where can that more complete version be found?
A On the same public ePrint server where Christy and I published our initial work.
Q What is an ePrint server?
A It's run by the National Science Foundation and Cornell University, and it's just a public repository where you place something, and then it's visible for all-time. It's what we do -- it's the main way we publish things initially.
Q And if you turn to Tab 4 in your notebook where we have Plaintiffs' Exhibit 3004, is that, in fact, that full published on ePrint paper that you were just discussing that you and your coauthors submitted for ePrint?
A Yes.

Q And what is the date that that was last published on that archive?
A It's date stamped 8th of May 2017 on the left-hand side on the margin.
Q Is that article that we're looking at behind Tab No. 4 available for anyone in the world who has an internet connection to see?
A Yes, it's publicly available.
Q Is it your intention to publish that article in a referee professional journal?
A Yes.
Q All right. My next questions are going to zoom in on some of the big picture conclusions that you state in that article behind Tab No. 4.

Before we get to the specific conclusions, I would like you to very briefly describe how you and your students went about evaluating the 2012 and 2016 Redistricting Plans adopted by the General Assembly as well as the Judges Plan. What was the means or mechanism to do that?
A So we generated a large number, over 24,000 maps, that adhered to the bipart -- the nonpartisan redistricting criteria laid out in House Bill 92. Then we took each of those maps, and we took the actual vote count from the 2012 or the 2016 elections, and we saw what outcome that map would produce, and then we tabulated all of those statistics, the outcomes of each

of those elections, as well as the partisan makeup of each of the districts, and then we used that to provide a background against which we could evaluate the Judges maps or the 2012 maps or the 2016 maps.

Q Okay. On page 3, in the second full paragraph of your article, "Redistricting, Drawing the Line," you say that the 2012 and 2016 Redistricting Plans produced results that are, quote, extremely atypical. What did you mean by that?

A What I meant was that over 99 percent of the maps we looked at produced more Democratic seats than those maps did.

Q In the next sentence, you say, quote, finer analysis clearly shows that the Democratic voters are clearly packed into a few districts, decreasing their power, while Republican voters are spread more evenly, thus increasing their power, unquote. What did you mean by that?

A So what I meant was that the maps we -- this ensemble of maps you created gave us a baseline, and when you compared the percentages in the most Democratic districts to those -- that baseline, there were clearly many, many more Democrats packed into those Democratic districts; and on the other hand, that allowed there to be many more Republicans in the next group of districts.

Q On page 9 of your article, just before Figure 6, you state that the 2012 and 2016 Redistricting Plans, quote, were precisely engineered and tuned to achieve a partisan goal,

unquote, and that, quote, the components of those plans were not randomly chosen, unquote. What did you mean?
A Well, we also did analysis where we moved slightly the boundaries of each of the districts to see how the makeup would change, how the partisan makeup would change, and we saw that when we shifted just as little as 10 percent of the boundary, the makeup of the districts changed dramatically. So if you were just to -- and I should say this is all nearby the actual maps. So if you were just to pick a map randomly nearby those maps, you would find a map that was very, very different.
Q And very different in what way?
A Much, much less advantageous to the Republicans.
Q By the time you concluded your work on this project, Dr. Mattingly, how many simulated plans or maps did you and your students come up with that would have satisfied what you would consider to be traditional redistricting criteria?
A Almost 120,000.
Q And from that, you ultimately selected how many? From that, how many were talked about in your article primarily?
A The main group -- because we started doing the analysis before we had -- the runs had completely finished, we used just over 24,000.
Q And of the 24,000 and of the 120,000, based upon your analysis, how many -- in how many of those plans, whether it was the 24,000 or the 120,000, would Democrats have scored more

congressional seats -- would have won more congressional seats than they did in the General Assembly's 2012 and 2016 Redistricting Plans?

A 99 percent -- over 99 percent.

Q Based upon the work that you did with your students, Dr. Mattingly, are you able to address the degree of partisan gerrymandering represented by the General Assembly's 2012 and 2016 Congressional Redistricting Plans?

A Yes.

Q And based upon that same work, are you able to address which of the districts in those plans are most affected by partisan gerrymandering?

A Yes, we can.

Q Dr. Mattingly, have you assisted us in preparing a PowerPoint presentation to help illustrate the work you and your students undertook that led to both your report in this case and to the article that we've been referencing?

A Yes, I did.

Q Is there anything in that PowerPoint that represents new or additional work beyond the work covered in the article, "Redistricting, Drawing the Line," that we were looking at, Exhibit 3004?

A There's not.

Q And would using that PowerPoint today assist you in both condensing and illustrating your testimony?

A It would greatly.

MR. EPSTEIN: Your Honors, at this point I would seek leave of the Court to ask Dr. Mattingly to step down to the monitor. We have the ability to show the PowerPoint on the monitor.

JUDGE OSTEEN: You may.

MR. EPSTEIN: Thank you. Okay. Can everybody see it? And if anybody needs to reposition -- I think they don't have it on their monitors.

JUDGE OSTEEN: We have a monitor issue?

MR. EPSTEIN: Let's proceed.

BY MR. EPSTEIN:

Q Dr. Mattingly, we're at the title slide, and we're going to move forward to the first full slide, and tell the Court -- you mentioned House Bill 92 before. Why, first of all, did you use the criteria from House Bill 92 for the work that you and your students did?

A We had already been considering many of these --

JUDGE BRITT: Excuse me. Can you use that microphone?

THE WITNESS: Would it be okay to move it this way?

JUDGE OSTEEN: Yeah, don't turn your back on us.

(Off-the-record discussion.)

BY MR. EPSTEIN:

Q Why don't you leave it there for a second.

A Just interrupt me at any moment if it's not audible.

JUDGE BRITT: Thank you very much.

THE WITNESS: So I was saying that we were already using most of these criteria already, but since we really wanted to interface with Tom Ross's project, we adopted precisely the criteria from House Bill 92.

BY MR. EPSTEIN:

Q Was House Bill 92 something that was enacted into law?

A No, it wasn't. It passed one of the chambers, but did not pass the other.

Q And was that in 2015?

A I believe so, yes.

Q Okay. Name the criteria, if you would, from that House bill?

A Sure. So continuity, so that means all the districts have to be connected, so they have to be not separated by other parts of the district. They have to have equal population, so "one person, one vote" as close as possible. You want them to be relatively compact. You want them to minimize the number of split counties, so a county which is in one congressional district and another one simultaneously, and adhere so far as possible to the Voting Rights Act.

Q And you may have been in the courtroom earlier when Mr. Speas described criteria that was adopted in February of 2016 after the original plan was held unconstitutional and had

to be redrawn. Are those the same criteria that were adopted by the legislature that we're looking at on the screen there?
A Well, except if you remove the partisan ones, yes. I mean, this is -- we didn't want to do anything -- the whole point was to do something nonpartisan.
Q And when you began your work, was that before or after the legislature adopted those criteria in February 2016?
A Well, the earliest work we did the summer before using almost the exact same criteria, that was before the legislature, but then the work with Beyond Gerrymandering was after that.
Q Okay. Let's go ahead to the next slide, and I'm going to ask you to explain this slide to explain how the Court used -- I'm sorry -- how you used computers to create what you call an ensemble, what I might call a collection of redistrictings to use?
A All right. So first what we did was we took each map that one might generate, and we assigned a score to it, and that score determined how good or bad or well it adhered to the criteria that had been laid out. So a low number is a good score, and that adheres better to the criteria than a high number. Then we used an algorithm. Using this, we put a distribution on all possible redistrictings, and then we used an algorithm called Markov Chain Monte Carlo to draw new districts.

Q Let me stop you. That algorithm that you just described, Markov Chain Monte Carlo, is that used in anything else besides redistricting?
A It's a very standard algorithm used in modern statistics. It has its origins going back to The Manhattan Project, and it's used in drug development, it's used in weather forecasting, it's used in machine loading, how SIRI works, et cetera.
Q Okay. Go ahead.
A And so then we tuned the score function just so that the districts we were producing had basic criteria that looked close to the districts that had been drawn before; and then, in particular, to really -- we took these districts that we generated using this. We generated many, over 150,000, and then we cut those down to some districts that had some bare minimal reasonable criteria, and those were that they had at most 1 percent population deviation. They had a minimum isoperimetric ratio of 6. And what is isoperimetric ratio? It's just a way of measuring compactness. So it keeps it from being a long hot dog. It tends to want to make things look more like a circle.

We made sure there were no counties that were split across three districts, and we made sure that at least one district had at least 40 percent African-Americans and at least one district had at least 33.5 percent African-Americans.

Q Let me stop you there. Why?
A Well, you know, we were basing this largely on these typical things by looking at what had -- the districts that had been drawn by the State, by the legislature, and the legislature had 44 percent in its 2016 map, had 44 percent African-American in the most African-American district, and I believe 36 percent, 36.2 percent, something around that, African-American in its second highest. So we tried to center our distribution to be around that, be, you know, on either side of that so we would be drawing ones that looked like what had been used.
Q And did that criterion also correspond with something that was in House Bill 92?
A Yes, House Bill 92 said quite explicitly that you had to -- you were not to use race except to satisfy federal laws, particularly the Voting Rights Act.
Q Okay. Go ahead, please.
A So, I mean -- so maybe it's useful just to think about this for a second. So what we're really doing -- so this is just an absolute minimum bar to get some set of reasonable districts, but then within that group of redistrictings, some redistrictings are more likely than others because they have a better score function. So we favored redistrictings that met this criteria better than those that didn't meet the criteria as well.

Q Were you able to take a large segment of redistricting maps and narrow it down in that way?
A So we had over 150,000 maps initially produced, and after this filtering procedure, this triage, we ended up with just over 24,000.
Q And if you were to use sort of a common everyday example of how you might think about this process as opposed to all of this fancy stuff, what would you say you did?
A So you have a bag, you're at a bingo parlor, and you want to pull tiles out, and some tiles are more frequent. The tiles in there that are more frequent are the maps. Each tile is a map of North Carolina, redistricting in North Carolina, and the tiles in there more frequently are tiles that satisfy well this score function; that is to say, they satisfy the criteria on the previous slide than the previous -- than the other tiles. And so we drew a tile out. That was the map of North Carolina. We took that map, and then we evaluated the elections based on the votes that were used in the 2012 and 2016 elections.
Q Okay. This next slide, it says: "VTDs Used to Create 13 Districts for All 24,518 Simulated Maps." Explain that.
A So this is the map of North Carolina voting tabulation districts, or essentially precincts in common parlance, and there's over 2,800.
Q And when it says it was used to create districts, 13 districts, what does that mean?

A Well, what it means is basically what we did was we assigned each of these voting-tabulation districts to a particular one of the 13 congressional districts. So every one of these districts has a number, which it's in our fictional District 1, our fictional District 2, our fictional District 3.
Q And why are there some areas on this map of voting-tabulation districts that are darker than others?
A Those are the more populous areas where there are many, many voting-tabulation districts packed in.
Q Okay. The next slide says on top "Actual Votes from 2012/2016 VTDs Applied to All 24,518 Simulated Maps." Explain, if you would.
A So once we had this collection of 24,000 maps, we took each map, which, of course, comes with it an assignment of which VDTs are in which of the 13 congressional districts, and then we took the actual map -- the actual votes, right. We have a record of what the votes are in each VTD from the Board of Election. We take that amount of votes, and we sum up all the votes in the VTDs that are labeled "District 1", and that gives us the votes in District 1. We take all the VTDs that are labeled 2, and we sum up their votes to get the votes in District 2, both Republican and Democrat to get the partisan makeup of those districts. Then we do that for every single one of those 24,000 maps, and that gives us, one, an indication -- a collection of outcomes of the election, and it

also gives us some detailed information about what the districts would look like.

Q When you're talking about the votes, you mean how many votes there were for Republican candidates and how many votes there were for Democratic candidates?

A Correct.

Q And which election cycles would you use for that purpose?

A The 2012 US House of Representatives elections and the 2016 House of Representatives elections.

Q Wasn't there an election in 2014 as well?

A There was. The problem was is that that election had one unopposed race. So if there's an unopposed race, the people in those precincts didn't have a chance to declare which way they would have voted because they only had one candidate presented to them. We considered and we had in other work -- we considered using a surrogate, using the Senate race, using the governor's race, using something else, but we thought that it was more powerful to just stick with clean results where we just use exactly the votes that were given.

Q And did your ensemble maps, the 24,000, have different results using the 2012 votes versus using the 2016 votes?

A Yes, I mean, the elections were very different, right. In 2012, there were 50 statewide. That doesn't say what happened at a local level, but there were just over 50 percent Democratic, and in the 2016, there was just over 46 percent

Democratic.
Q And in parenthesis you have listed there "seats." What is that referring to?
A So this is the actual outcome of the 2012 election. So in the 2012 election, using the legislature's 2012 map, four Democrats were elected from 50 percent of the vote and nine Republicans were elected from only 48.75 percent, and, likewise, three and ten. And part of the goal of this was to understand whether -- to what extent this was determined by geography of the state and the distribution of where people live or whether this was something else going on.
Q And did those distribution of seats wind up being different from 2012 to 2016 in your 24,000 plans in a similar fashion as we see there for the actual congressional actions?
A Yes, very much.
Q And is that because the vote was different in 2016?
A Yes.
Q All right. This slide says: "Planned, Analyzed Against Simulated Maps Ensemble." Can you explain it, please.
A Yes. So once we have this ensemble, which we've tabulated all these elections, 24,000 elections, using actual votes each time, that gives us a background signal, and then we go and compare the results that one would have had using the Judges map in 2012 and 2016 and the actual map used in 2012 and the actual map used in 2016. So this NC 2016, that's the actual

map from the legislature. NC 2012 is the actual map --
Q And why were you using these colors, green for judges, red for NC 2012, and blue for NC 2016?
A Because I needed three colors that had some contrast.
Q And are those colors going to be consistent throughout this PowerPoint?
A Yes.
Q All right. Now, let's go to this next slide that says: "Outcomes Among 24,518 Simulated Maps, Votes for the US House 2012." Explain to the judges what we're looking at in this slide, what the significant information is that you want them to get.
A So as I mentioned before, we took these 24,000 -- just over 24,000 maps, and we took the actual votes from the 2012 election, and we tabulated the partisan makeup of the delegation using that map; and when we did that, we kept track of the number of Democrats who were elected each time, and this histogram gives you the number of Democrats elected each time. So out of the 24,000 maps, using the actual 2012 votes, just 38 percent had six Democrats. So that's four -- 9,455, I won't keep reading the numbers, and then seven were elected 39.52 percent of the time, and you see here just under 12 percent had five Democrats elected, just under -- just over 9 percent had eight Democrats elected.
Q Would it be correct to say that in over 99.6 percent of

your simulated maps, five or more Democrats would have won congressional seats in 2012 had the votes been cast the same as they were in 2012?

A Yes. So that's summing up the total percentages in these quads. So this is -- five or greater would be this way.

Q And would over 88 percent of your simulated maps have had six or more Democrats elected?

A Right. So that's the same thing; you add up these numbers here. So that's all of the outcomes to this side.

Q And the most likely outcomes in your simulated maps with over 79 percent were what?

A Six and seven, slightly more, but indistinguishably.

Q And according to the data from all of those simulated maps, was a map resulting in nine Democratic wins just about as likely as a map resulting in four Democratic wins?

A I mean, first of all, both of them were very unlikely, but each -- they were about equally likely to get nine Democrats as it was to get four Democrats.

Q Okay. Did you then use your ensemble, as you explained to us earlier, to compare the three plans: The Judges Plan, the North Carolina 2012 Plan, and the North Carolina 2016 Plan?

A I lost the question. Could you --

Q Did you then use this ensemble data to compare what the Judges outcome was, what the North Carolina 2012 Plan, and 2016 Plan outcome was?

A So we -- we calculated what -- how many -- there you go. We calculated it using the Judges Plan. So the Judges redistricting map, there would've been nine -- I mean, six Democrats elected, excuse me, six Democrats elected.
Q Okay. And what about the North Carolina 2012 Plan?
A There would've been four Democrats elected.
Q All right. And what about the North Carolina 2016 Plan?
A So, again, four Democrats. It's important to remember that we're still using the 2012 votes. We're just using the plan from 2016. So if we used the 2012 votes in the 2016 plan, we would have had four Democrats elected.
Q Okay. Let's go to this next slide, which I think is going to require some more explanation; but before you do, I'm going to read the title. It says: "Analysis of 13 Districts in Simulated Maps, Votes for US House 2012." Now, please take some time and explain to the Court what we're looking at in this slide.
A So the broad picture is we're trying to understand what that background signal was, what -- how -- the geopolitical makeup of North Carolina, both the shape of the state and where the people live, and the partisan makeup of where they live would give us -- would tell us what we would typically see. That's what we're trying to get at.

So to establish that, what we did was we took every map that we generated, every map that we had, and we ran the

2012 elections. So we have 13 congressional districts. There's the most Republican, the second most Republican, the third most Republican, the fourth most Republican, the most Democrat, the second most Democrat. So we ordered those numbers, in other words, what's the percent -- the fraction of Democratic vote -- the percent of Democratic vote, and we ordered the districts from the most Republican to the most Democrat. So that's these 13 numbers. These are not the numbers associated with the districts as we see them when we talk about District 12 or District 1. These are just the most Republican, the most Democrat.

So we take those 13 numbers for each of our maps, and then we make this plot to summarize those statistics. So what this plot shows you is that if you took the most Democratic map, most Democratic -- I misspoke -- the most Democratic district in each of the 24,000 maps, so if you took the most Democratic district in each of the 24,000 maps and you said what was the fraction of Democrats in that map, the median would be just around 67 percent, and how could that be helpful to you? You might -- somebody might come to you and say, you know, isn't it weird that this district has 67 percent Democrats in it? That seems nefarious, but if, in fact, it was the most Democratic district, that's what you would expect to see. Just typically when you draw maps of North Carolina, that's what you end up with.

And then we did the same for the twelfth most Democratic, the eleventh most, the tenth most, the first most Republican, the second most Republican, the third most, the fourth most Republican.

Now, just to unpack a little bit what this figure shows you is the central line here is the median, which in these cases is identical essentially to the mean. So it's the line that splits 50 percent above and 50 percent below.

Q 50 percent of the 24,000 --

A Yes.

Q Okay.

A And then this box here, this is called a box plot, if you want to look it up later. So this box here holds 50 percent of all the maps. So all the maps had their most Democratic district with a percentage that was in between these two -- these two upper levels of the box.

Q You said "all." Did you mean 50 percent?

A I meant, yeah, 50 percent. I misspoke. Then there are these whiskers, and these whiskers are supposed to demonstrate what are outliers, what are exceptionally far from the mean, and the reason these are chosen, these are 1.5 times this box distance, and that's for the reason that if something was Gaussian, if something was normally distributed, 98 percent -- over 98 percent would be outside of these whiskers.

Q Okay. Talk about the 50 percent line, that dark in the

line. What is that showing us with respect to each of these districts?

A Well, I mean, as we all know, whoever gets the most votes in a district, wins the seat. So this line is the 50 percent line. So if a map had -- each of these maps is a dot going up here, has -- the number of dots that are above this line is the number of seats the Democrats won, and the number of dots below this line is the number of seats the Republicans won. So we saw in the previous plot it was between six and seven typically, right. And you notice that it's exactly the seventh most Republican district that straddles the 50 percent line. So it's exactly typically split between 50 percent of the time favoring the Republicans and 50 percent of the time favoring the Democrats.

Q And in your box plot, would that be the most competitive district, the seventh most Republican district?

A Yes, this would be the most. I mean, it would be essentially -- depending on the map, it would be 50/50 to be more favoring the Democrats and more favoring the Republicans.

Q Is that always going to be true, or it depends upon the elections -- the votes that you're dropping in?

A It depends upon the election. So, typically, what we see is if this general structure of the box plot looks the same, but in the year when the populous vote is more Republican, then necessarily the whole box plot shifts downward, thereby putting

more of the boxes below the 50 percent line, and in a year when the populous vote is more Democratic, the box plot shifts upward, thereby putting more of the boxes above the 50 percent line.

Q In other words, the line always stay -- the 50 percent line always stays in the same place?

A Right.

Q And the box plot is up or down?

A Right.

Q Okay. Which are the least competitive districts in this box plot?

A Clearly, the most Republican usually goes to the Republican Party, and the most Democratic district tends to go to the Democratic. We're separated enough geographically that we're not mixed in a blender. It's spread evenly over the state.

Q Does this box plot also show you the variability of the outcomes within individual districts?

A Yes. I mean, this says that over different maps, we typically had a variation of this much in the percentage of most Democratic, and, in particular, this one it shows that about half the map favored the Democrats a little bit and about half the map favored the Republicans.

Q Which of these districts on this box plot shows to be the most variable in your ensemble?

A I mean, it's close, but I would say this one. I mean, it both has the biggest outliers and the biggest 50 percent box.
Q And which would be the least variable?
A This sixth most Republican district. It has a very tight 50 percent box and a rather tight outlier box.
Q And just to make sure we're clear on this, the numbers at the bottom on the horizontal axle, the two, the four, the six, the eight, the ten, the twelve, they represent what?
A They do not represent the labeling that we used, the twelve districts. They represent how they order -- how the lines order, whether they're the most Republican, the second most Republican, the third most Republican, the most Democrat, the second most Democrat, the third most Democrat.
Q Okay. Let's move forward now, and you've drawn on this next one the exact same box plot with a yellow line. Tell the Court, if you would, what the yellow line is representing and what you believe the significance of that yellow line is.
A Well, the yellow line connects all the medians through the center. So this gives you some idea of typically what one would expect to see, given the geography of North Carolina and what -- the distribution of people in North Carolina.
Q Okay. And remind the Court what the inputs were that went into getting a yellow line looks like that.
A So we used the 24,000 maps to tabulate the actual votes from the 2012 election and see how much they varied across

maps.
Q And the 24,000 maps were created using what criteria?
A They were created using the nonpartisan criteria laid out in House Bill 92, just population deviation, compactness, not splitting counties and satisfying the VRA, at least at the level of the 2016 congressional maps.
Q And in all of the work that you've done on gerrymandering issues, in your opinion, is the shape of that yellow line significant?
A Yes, I mean, this -- when I started off talking, I said we wanted to understand was the 2012 typical, you know, what would one expect. This gives a much finer detailed structure of what one would typically see. This is kind of the signal in the election, as far as I'm concerned.
Q Of how the voting in the individual districts compare to one another?
A Correct.
Q All right. What would you expect to see if the districts had been gerrymandered to give one party an extreme partisan advantage?
A Well, let's say that they had been biased to the Democrats. You would expect to see a depression here where many Republicans are impacted here, and then some districts where they had been removed from, or, alternatively, if it had done the other way, if it had been given the Republicans an

advantage, you would have many more Democrats packed in the most Democratic districts, and then the Republican districts -- the next set of districts would have many more Republicans because that would bring it down towards the 50 percent line.

Q And what would the line as a whole -- instead of that gradual sloping yellow line, what would that line look like?

A Well, I mean, it would be flatter here, and then it would jump up particularly to a flatness here, so it would have an S-shape there.

Q All right. Go ahead and tell the Court what you've done on this next slide that adds more information.

A So I've added the green dots. Green is always the Beyond Gerrymandering Project with Tom Ross. So these are the districts that the panel of six Republican and six Democrat judges produced, and we see that they're pretty good, especially right here in the middle part. They fall at least sometimes dead center, but usually typically pretty close to the 50 percent box. Definitely none of them are in the outliers.

Q And what criteria did the Beyond Gerrymandering Project use to create their map?

A They -- they just followed House Bill 92.

Q With respect to this issue of gerrymandering, did the green dots tell you anything as to the Judges Plan, what they produced?

A Well, I mean, it seems to be very typical. It follows very closely that yellow line we had before.
Q Okay. This is -- explain to the judge what we're looking at in this next slide with the red dots.
A So this is now the makeup of the districts for the 2012 Legislative Plan, and you see very much what I was talking about before. You see that these most three Democratic districts have an anomalously large number of Democrats packed into them, and these four or even five districts here have many less Democrats than they would typically see.
Q Okay. And these were actual districts voting in the 2012 election?
A Right. These are -- where these are -- these box plots are the signal -- from my ensemble of 24,000, these are the actual makeups of the election results.
Q And when we're looking at the previous slide, which I'll go back to for a second, those weren't actual votes that created those green dots. What were they?
A They were actual votes.
Q I'm sorry. They weren't actual votes in an election with the judges map?
A No, they were using the votes at the precinct level in the 2012 election, but then assigning them to districts according to the judges maps.
Q Okay. As you did for your ensemble?

A Correct.
Q Okay. Let's go ahead now. What labeling have you added to the horizontal axis on this slide?
A So now we've actually replaced them with the numbers that one usually thinks of Congressional District 1, Congressional District 12, Congressional District 7, 4. So you can see where they fall in this ordering of districts, starting at the most Republican and the most Democratic.
Q The most Republican was?
A The most Republican was District 3.
Q And the most Democratic?
A District 12.
Q The box plot with the whiskers and the box in the middle, are those specific to those districts you see on the horizontal axis?
A No, no, these have nothing to do with these numbers. These are from our redistricting. The number here just applies to this number here, the actual outcome of the 2012 election. So this is --
Q I'm sorry. Are you ready to go to that slide?
A Yes.
Q Okay. All right. So let's go to this next slide in which you've added a whole bunch of additional labeling. Take your time and tell the Court what additional labeling you've added.
A So just to help ground this and make sure that we all

understand what we're talking about, I've added the percentages of -- the Democratic percentages in each of the districts. So in that election, the most Democratic, District 12, had 79 percent Democrats. The next one had 76, District 1. The next one had 74, District 4.

And if you compare those to what we would expect from our ensemble, the medians had a difference of plus 11 here, plus 14 percent, plus 15 percent. So there were many more percentage Democrats in these districts than what we typically see, and, conversely, in the next four, there were many less Democrats. In fact, this one had 50 percent Democrats when normally one would expect to see 57 percent Democrats, the next most Republican had 49 percent when one would typically see 55 percent, and then 46 percent when one would typically see 52 percent, and 44 percent when one would typically see 50 percent.

Q Did you consider those differentials that you were just looking at as between the median vote in your ensemble and the actual vote in 2012 significant with respect to this issue of partisan gerrymandering?

A Yes, I mean, this shows that these districts have been moved to become Republican, while these have been made even safer Democratic.

Q What's the relationship between safer Democratic seats and districts that can become more Republican?

A Well, you have to take the votes out of here and move them here, and that's what this clearly shows.
Q Okay. This next slide has added a little bit of more information. Can you tell the Court what additional information is on this slide?
A Right. So what you want to understand, though, is that a typical result? Are there some of our 24,000 elections in my ensemble that have that structure? And what this gives is this tells you -- for instance, each of these numbers here gives the percentage of the maps in the 24,000 ensemble, which had a value above this whisker. So 99.99 percent had values below this whisker, and this is this map, the 2012 map.

None of the maps in my ensemble had values as high as this whisker here, and this is the value for the 2012 map. 99.31 percent had a value below this whisker, and this is the value for the 2012 map. Conversely, you would want to know how many are below this whisker or how many are above. So only 1.5 percent, just over 1 percent, had a value below this whisker, and this one is all the way down here. Similarly, at this whisker, only .43 percent had a value -- had a value or percentage below this one, .04 percent had a value below this whisker, and .07 below this. We label these as "extreme outliers" one by one.
Q Does this slide, in your opinion, present any evidence regarding partisan gerrymandering of individual districts?

A Yes, I mean, since you can look at these districts, it seems to say that this clump of districts -- for instance, let's start here. This clump of districts here, 4, 1, and 12, actual Districts 4, 1, and 12, had significantly more Democrats than one would typically see, even though they are the most Democratic, and then the next four had many, many less Democrats than what we would expect to see.

Q Dr. Mattingly, did you actually add up how many Democratic votes there were in the three most Democratic districts, 4, 1, and 2, in that election?

A I did.

Q Do you have your cheat sheet telling you how many?

A There were 765,000.

Q Democratic votes?

A Democratic votes in these three.

Q And then for -- well, let me ask you: In your ensemble of maps, 24,000, how many had that many Democratic votes?

A None.

Q Okay. For the next three districts, the ones that are -- on your map, they are District 7, District 9, and District 8. Can you tell the Court how many Democratic votes were in those three in the actual election?

A So these had 665,000 --

Q I'm sorry. No --

A 765,000, and these three here had only 520,000.

Q How many simulated maps in your 24,000 had that few Democratic votes in those districts?
A None did.
Q And is that significant in your opinion?
A Yes. I mean, it shows that if one were to draw maps using these criteria, it was extremely unlikely to ever end up with a situation like this. In fact, it was essentially -- it was impossible.
Q In your opinion, could the legislature have created a redistricting plan that yielded those specific results unintentionally?
A No.
Q Okay. Let's go to the next slide. Tell the Court what we're looking at. It says: "Comparison of Results: Ensemble, Judges, NC 2012." What are we looking at, and what do you find significant?
A Well, so, as I said, this yellow line that connected the medians was my background signal. It's what I would typically expect to see, and you might ask, well, could a set of human beings sit down and draw such a map. Well, the judges did without having access to this. We did this after the fact. So the judges drew the maps that created this green line, which very closely adheres to the yellow line. On the other hand, you see the legislature's maps are very flat here and then take this huge jump and go up here. So for me, when I see anything

like this, a plot like this, this kind of S-shape thing, you know, this is what I mean by gerrymandering. This is the signature of gerrymandering.

Q All right. Now, we've just been through the 2012 Plan and looked at the 2012 votes that actually occurred under the 2012 Plan. Did you perform the same exercise for the 2016 Plan and the 2016 votes?

A Exactly the same exercise.

Q All right. Let's go through it, and let's start with what you called the histogram, showing the outcomes in 2016 using the 2016 Plan?

A All right. So, again, we typically had five Democrats elected. So this is a year when there was more -- the vote was more Republican, so 53 percent Republican and 47 percent Democrat. So only five were elected, Democrats, and sometimes four and sometimes six typically.

Q Okay. And what were the percentages of those three?

A Just under 28 percent had four, just over 55 percent had five Democrats elected, and just shy of 16 percent had six.

Q So would it be correct to say that in over 99.3 percent of your 24,000 simulated maps, four or more Democrats would have won congressional races in 2016?

A Yes, that's just adding up the percentages in these --

Q And in over 71 percent of those simulated maps, five or more Democrats would have won?

A Yes, that's correct. That's, again, just adding up these last three.
Q And was there one outcome that actually had the majority in your 24,000 maps?
A Five Democrats elected.
Q Statistically speaking, was it just about as likely that Democrats could have won seven seats had only mutual redistricting criteria been used as it was for Democrats to win only three?
A Yes, they would have both been very unlikely, but they would have been equally likely approximately.
Q Okay. And did you apply three plans, the Judges Plan, the NC 2012, and NC 2016 to this histogram?
A Yes, we did.
Q And where do the Judges come out?
A So the Judges had four Democrats.
Q Assuming the 2016 votes were used?
A Yes, take the full sentence. So using 2016 votes, we had four for the Judges. When we looked at the NC 2012 Plan -- so, again, just to be clear, we're using the plans, and we're using the 2012 election, but we're using the votes from the 2016 election. So they produced three this time.
Q Okay. And for the NC 2016 Plan?
A So this is the actual plan that was used in this election, and they produced three.

Q Now, going ahead to your ensemble, what do you see here in your ensemble with the yellow line?
A So, basically, you see a box plot that looks very similar to the previous one. It has a nice gradual progression of the median very much in the same way, but if you look a little closer, you will notice that the whole box plot has shifted downward, right. It crosses the 50 percent line now just between eight and nine, and that was because this was a more Republican electorate.
Q And does that show why five Democratic wins was the majority outcome, looking at your box plot?
A Right, yes, because typically one had eight here, and so if eight is here, that leaves five.
Q Five that were above the line?
A Five above the line, one, two, three, four, five.
Q Okay. Is the type of line that we see, the yellow line there, comparable, in your opinion, to the type of yellow line that we saw in 2012 -- using the 2012 Plan and 2012 votes?
A Right, it's a nice gradual line that doesn't have any sharp kinks, and it just -- so as the vote moves up or down, you gradually gain or loss a seat in a nice progressive way as the percentage changes.
Q Okay. I want to move back to one thing that I neglected to ask you. Back here with the Judges Plan that came out with four, four Democrats winning out of 13, can one say that, well,

that's pretty similar to the outcome of three that was actually achieved under the 2016 Plan?
A Well, I mean, the numbers are close, but this one is 42 percent more likely than this one.
Q 42 percent or 42 times?
A I'm sorry. I misspoke. Thank you. Forty-two times more likely. So if it's 42 times more likely to get four Democrats than it was to get three Democrats in our ensemble.
Q And did you actually, in your analysis and in your paper, include a histogram showing whether the judges were close to getting -- the Judges Plan was close to an outcome of five?
A Yes, so, in fact, there's a more nuanced analysis. I think it's Figure 11. Let me double-check. While I'm getting it, I'll talk.
Q So in that --
A Yeah, it's Figure 11. It shows where -- how close they were, in other words, how close one would expect them to flip, and the Judges Plan was actually right over here. So one would expect that small changes in the distribution of votes would actually move it to five.
Q Okay. Let's move forward to where we were with the yellow line. Which should have been -- according to your ensemble of 24,000 maps, using the 2016 votes, which should have been the most competitive districts?
A Well, it should have been typically the eighth most

Republican and the ninth most Republican.
Q Okay. And each of those --
A But that's not District 8 and District 9. That's if you order them, it's the eighth most and the ninth most.
Q And in each of those, would the winning share and the median have been less than 55 percent?
A Say that again.
Q For the medians on those two, would the winning share of vote, whether it was Democrat or Republican, have been less than 55?
A It would've been less than 55, yes, typically. The box plot here is where only 50 percent of the map is less than 55, which is about here.
Q Did you also plot the Judges and the 2016 results as against your ensemble?
A Yes, we did exactly the same analysis as before. Here they are. So, again, they have a fairly gradual uptick. This one is a little bit outside the box, but still not in the outlier band, and the rest of them are pretty where you'd.
Q And what, in your opinion, does that say about partisan gerrymandering of the Judges Plan?
A It's not gerrymandering.
Q Okay. Let's go ahead to the 2016 Plan with the 2016 votes.
A Well, we again see the same structure as before. So the

last time we were looking at the 2012 map. Now we're looking at the 2016 map, and, again, we see this very flat region here with many, many less Democrats in these three in particular and many, many more Democrats in these three.

Q Would you agree that the first seven districts are roughly similar to what we saw in the Judges Plan in your ensemble?

A Yes, in fact, even this one is lower. So some of these other ones have pulled up, but these basically look quite similar to the rest.

Q So which half of this slide is the one that is dissimilar from the Judges and from your ensemble?

A This one, this half, the half towards the Democratic districts.

Q Okay. Let's go to the next slide. What are we showing on this slide?

A We've actually labeled now -- this is -- now we've put the actual districts -- the districts are on the map, the District 1 that we know, District 4, District 12, District 13, District 2, District 9, District 5.

Q And let's go to the next slide. Tell the Court what additional data and information you've supplied on this slide.

A So now we've actually labeled the partisan makeup. So first for the House -- for the 2016 map, the most Democrat had 70 percent, now the next most had 68, the next most had 67, but that should be compared with 65, 62, and 57. So it's plus 10

percent, plus 6 percent, plus 5 percent, and then these next three districts had 44 compared to 54, so minus 10 less Democrats; 51 to 43, minus 8; and 48 to 42, minus 6.

Q Okay. Does this -- let me back up. Let's go to the next slide -- well, let me -- sorry, I apologize. Did you consider those differentials at the bottom of the slide to be significant on this issue of partisan gerrymandering?

A Yes, I mean, this is, again, the structure which makes -- this kind of structure like this is the signature of something being gerrymandered.

Q With respect to the numbers at the bottom, the minus 10, the minus 6, what is that telling us on this topic of partisan gerrymandering?

A That these districts had many, many more Democrats than typically is found if one were to draw bipartisan maps.

JUDGE WYNN: Counsel, I'm concerned of the record that's being created here. We don't have a visual of this, and when you say these districts and don't specify where they are, we are not going to have a clear picture of what you're talking about upon review of this. So if you would direct him to be more specific so that we can have the record of this.

MR. EPSTEIN: Thank you, Your Honor.

BY MR. EPSTEIN:

Q Can you be more specific, when you're talking about these districts, what you're referring to?

A So the three most Democratic districts, the one farthest to the right, have many more Democratic votes than one would expect to see if one looked at the medians or the box plots for those three districts that are the most Democratic, and then when you compared the next three most Democratic, that is, the next three after those first three, one sees that they have many less Democratic votes than one would expect when one compares to the medians, that is, the lines in the center of the box plots.

JUDGE OSTEEN: The actual district is down on the bottom, right?

THE WITNESS: Yeah, these are the actual numbers of the districts, so it's the very bottom of the slide.

JUDGE OSTEEN: So I think when you're talking about the most Democratic district, if you'll identify that as CD1, CD4, and CD12 in addition to what else you're going to say.

THE WITNESS: CD?

JUDGE OSTEEN: Or D. You used D.

THE WITNESS: D here is the actual district on the map. So that one just happens to be one. This would be the second most Democratic district, which is labeled District 4 traditionally, if you use the maps. Now, that doesn't mean that it exactly corresponds to the most Democratic district in every one of the ensembles. Where that is geographically can move around, depending on the random map.

BY MR. EPSTEIN:
Q Okay. And I think this next question, Dr. Mattingly, will help orient us to the most Democratic districts. Did you add up how many Democratic votes there were in the three most Democratic districts in 2016, District 12, District 4, and District 1?
A So in the three most Democratic, three farthest to the right, there were just around 750,000 Democratic votes.
Q How many simulated maps in your 24,000 had that many Democratic votes using the 2016 votes in their three most Democratic districts?
A None.
Q Did you add up how many Democratic votes there were in the next three most Democratic districts, which were District 13, District 2, and District 9 in 2016?
A Yes, just shy of 600,000.
Q How many simulated maps in your 24,000 had that few Democratic votes using the 2016 votes in the fourth, fifth, and sixth most Democratic districts combined?
A None of them did.
Q Is that significant in your opinion?
A Yes.
Q Why?
A It means that it's extremely unlikely that one would have produced maps that had that level of packing here and that

level of depletion here unintentionally or using nonpartisan criteria.

Q All right. Let's go ahead and look at the next slide. We've added in the information about those whiskers, and be specific, when you're talking about individual district and the whisker, which district you're talking about.

A Okay. Again, now we're going through -- if we look at each of these districts, how atypical was the value of percentage in that district, as high or as low as it was.

So in the first most Democratic district, the one farthest to the right, which had 70 percent Democrat and is above this whisker here, that top whisker, only .61 percent of the maps had a value above that whisker. Similarly, for the next one moving to the left, none of the maps had a value above this whisker, while the maps from the legislature did. Moving to the third one in from the left, only .07 percent, or, in other words, 99.93 percent, had a value below this whisker, while the maps from the legislature had one just above it.

Then moving to the districts which seemed to have less Democrats in them, the fourth most Democratic district, moving from the left -- from the right, sorry, had -- below the whisker only .19 percent, or 99.81 percent, had a value -- had a value above this whisker. So this was very atypical. It was very much an outlier, and the same thing as with the last two with .53 percent being below this whisker and only .02 being

below this whisker. Now, this one falls just above that, but it's still well outside of this box.

Q And what does the information that you've just been through, the whiskers and where the plot points for the Republican Plan comes -- what does that tell you about how likely the result obtained would be if only neutral nonpartisan redistricting criteria had been used?

A Well, based on the ensemble that we generated, these would be essentially impossible to generate randomly. They would be so highly atypical that one would not see it.

Q And in your opinion, could the legislature have created a redistricting plan that yielded the results we're looking at on this slide unintentionally?

A No.

Q All right. Go ahead and tell the Court what we're looking at in this slide with reference to comparing results in the 2016 -- with the 2016 votes.

JUDGE BRITT: Mr. Epstein, let me ask you another question that follows what Judge Wynn said. Do these slides follow some of the drawings in the paper?

MR. EPSTEIN: They do, Your Honor. There's a little bit more precision in them in terms of -- these lines are all there. They're just not -- the plot points aren't connected. They are the same exact graphs and charts as are in the paper with differences. Here the lines are drawn in.

JUDGE BRITT: Well, I was just wondering if it would be helpful for the record, Judge Wynn, for this to be -- when he's talking about a slide, to refer to a figure in his paper.

MR. EPSTEIN: Your Honor, actually, it might be easier. We have -- I was going to ask at the end to introduce this as an exhibit and have it admitted for illustrative purposes. We have them, and we can hand them to the Court either now or at the end of his presentation, but we do have them.

JUDGE BRITT: At the end would be fine.

JUDGE WYNN: Actually, I think it would be helpful to hand them now, and then we can point to them. Where we're going with this is that when we review this and if you just say "this" and "that," we're going to have some difficulty ascertaining what you mean, and simply all you got to do is point to the particular slide, indicate the figures that you were talking about, and it's going to be pretty easy. We're smart, but we're not that smart, I don't think.

MR. EPSTEIN: If Your Honor can give me a moment, I can have our paralegal sort through them and hand them out right now.

JUDGE OSTEEN: Let's take about a 10-minute mid-morning recess, and then we'll come back.

(At 11:05 a.m., break taken.)

(At 11:20 a.m., break concluded.)

JUDGE OSTEEN: Before we resume testimony, in terms of exhibits, my normal practice is the witness is handed an exhibit. It's -- the witness identifies the exhibit. We take a moment to see if there are any objections. If not, move the admission of the exhibit, and then we have it in front of us.

Even with the screens, especially with three judges on the bench, it's difficult. So going forward, to the extent we have paper copies for the Court -- I know I asked for zip drives, but if you don't have them for me, don't worry about it; but if you have paper copies, go through that process so we actually have our copy of the exhibit in front of us while you go along.

MR. EPSTEIN: Thank you, Your Honor. At this point, first of all, I would note that we do have zip drives for the Court, law clerks, and everyone, which we'll be happy to distribute at a break, but we would move the admission as an illustrative exhibit Plaintiffs' Exhibit No. 3040.

JUDGE OSTEEN: All right. Any objection to that?

MR. STRACH: No, Your Honor.

JUDGE OSTEEN: Plaintiffs' Exhibit 3040 is admitted.

MR. EPSTEIN: May I ask the witness to resume?

JUDGE OSTEEN: You may.

BY MR. EPSTEIN:

Q Okay. Dr. Mattingly, before we took our break, we were looking at this slide that says "Comparison of Results" and

it's Ensemble, Judges, NC 2016, and it's using the 2016 votes. Using your pointer, please, can you walk you us through what you find significant about this slide.

A I think it's probably a good idea if I used the colors. That way it will help everyone know what I'm talking about.

JUDGE BRITT: I'm not getting any feedback from that microphone right now. Can anyone tell me why?

MR. EPSTEIN: Please speak more loudly.

JUDGE BRITT: It was probably my -- it's clear now.

THE WITNESS: Is this too loud, or is this good?

JUDGE BRITT: No, no, it was not your problem. It was right here.

THE WITNESS: All right. So the yellow line that passes through the centers, that's through the median, and that's what I would -- it's typically typical given what we see in our ensemble, and then the green line, which passes very close to the yellow line, is what the Judges map produced, and this blue line deviates quite a bit. This is the NC 2016 Plan. And so, once again, we see the same kind of S-like structure that we saw before.

BY MR. EPSTEIN:

Q And what is significant about that S-like structure to you?

A Well, it is a signature of gerrymandering in the sense that these have many, many more -- many, many more Democratic

votes, that is to say, the right most three, the three most Democratic districts have many more Democratic votes than one would typically see, and the next three have a very flat structure with many less Democratic votes than one would typically see.

Q And for the record, just for the Court, I'll refer to this as Slide 30. I should have been doing that from the beginning, and I apologize for not doing that so the record is little bit clearer.

Dr. Mattingly, did you do any work to validate the results of your work to make sure that they weren't overly influenced by one factor or another?

A We did.

Q What did you do to validate your results, among other things?

A Well, one thing we did was -- you might ask was this enough samples? Did we sample this distribution on redistrictings well enough? Did we have enough maps? So --

Q Going to Slide 31, can you answer that question?

A Yes. So what I've been describing to you largely is the result of using 24 -- just over 24,000 maps. We also took a longer run of just shy of 120,000 maps, and using those maps, we produced the histograms, the two we've been talking about, the histogram that shows the election results, and you see that there's essentially no deviation. The blue is the smaller

ensemble, and the yellow one is the much larger ensemble. So this says that the results have stabilized and adding more ensemble -- adding more samples won't change anything.

Q So what does that say about the size of 24,000 as your original ensemble?

A It was at least sufficient. It doesn't mean that less couldn't have been equally sufficient.

Q And this was studying the 2012 votes with the larger sample size?

A Correct.

Q Okay. Let's go to what I'll call Slide No. 32, and this is the box plot that corresponds with what we were just looking at, the histogram. I'm sorry. I need to go -- there we go.

A So this is the box plot again. Again, the yellow box plots are the larger sample, 120,000 or so, and the blue box plots are the ones we've been talking about, and you see that they have almost identical structure. If you look at them next to each other, they look essentially the same. So that means all the conclusions that we drew so far would be stable using the larger ensemble.

Q All right. And did you do the same analysis using the 2016 votes?

A Yes.

Q Going to Slide No. 33, can you explain what we're looking at there?

A Again, exactly the same thing. The blue is the smaller ensemble we've been talking about up until now, and the yellow is the larger, just shy of 120,000, and you see essentially zero change between the two.
Q And what does that tell you about whether using the 24,000 was enough to be looking at?
A Again, it shows the results are stable. 24,000 was more than enough to produce the good results.
Q And when we go to Slide 34 and look at the box plot structure for the 2016 votes, what does that tell you with 119,000 samples?
A Again, the two sets of box plots line up essentially identically. The medians are in the same places, the 50 percent boxes are essentially lining up actually, and even the outliers are coming in the same places.
Q All right. Dr. Mattingly, one of the things you talked about when you were looking at House Bill 92 and those criteria that were used, both by your students and you, on the one hand, The Beyond Gerrymandering Project, on the other, was a criterion that dealt with county splits, minimizing county splits.

Did you take a look at your ensemble with reference to the subject of county splits?
A We did.
Q Okay. I'm going to go to Slide 35 and ask you to explain

to the Court what we're looking at in that histogram.
A So we wanted to understand what the distribution of county splits we had in our ensemble of 24,000 maps, and this light blue histogram gives that collection. So, typically, we saw around -- the median is around 22, I would say, and it ranges from somewhere around 17 to somewhere around 27, but we were also interested -- you know, when we say a county split, that means the tiniest bit that the legislative districts might leak into a county, and we count that as a split. Those kinds of things could easily be fixed by hand, by moving a few districts across the line.

What we wanted to see was how many significant splits we had. So we asked ourselves, well, a significant split is where the smaller part is at least 10 percent of the county, and when we did that, we got this darker blue. So if we only count significant splits, we're down to around 17, 18, 19 typically, and down as far as 13, 14.
Q Do you know how many counties were split in the 2012 Redistricting Plan enacted by the legislature?
A I believe it was 40.
Q Were all 24,518 plans in your ensemble below that number?
A Yes, we did a hard threshold to ensure that we never considered a map in our 24,000 which had more than a 40-county split.
Q Okay. Did you also do some validation work around this

subject of county splits to make sure that your ensemble was fairly representative?
A Right, so we were interested if decreasing the number of county splits would have any qualitative effect on the results, largely because the 2016 had 13.
Q Let's go to Slide 36, and it says "Validating the Results: The Effect of Doubling Weight Against County Splits."
A So we created a brand-new ensemble. So we generated a new collection of maps where we -- in our score function, we penalized districts -- redistrictings that had more county splits. We increased the penalty, so thereby decreasing the chance of drawing a map that had a large number of county splits. This is that collection we produced, and this is the number of county splits. So now you see this one we haven't even -- this is just any split. We haven't even asked what's the 10 percent, what's the significant county split, and it's already down -- typically down 14, 16, 17, and going all the way down to around 11.
Q And did you then take this collection and look at the results that you would have obtained using just this sample?
A Right, so we wanted to compare the results we had before and the results with this new ensemble which had -- which concentrated on having less county splitting.
Q Okay. And let's go to Slide 37, and is that a --
JUDGE OSTEEN: Hold on just a second. Let me go back

to 35. I'm not sure I understand the colors. So the -- on the left side of the graph, you have the darker blue. That's the splits greater than 10 percent?

THE WITNESS: Yes, Your Honor.

JUDGE OSTEEN: All right. And then there's that purply color in the middle. What is that?

THE WITNESS: That's just -- they're transparent. So where the two box plots -- where the two graphs go over each other, that's so you can see the dark one in the background. So this one coming down -- this is the significant splits and then coming down, and then this one -- you can think of this one being in front, the light blue.

JUDGE OSTEEN: Hold on. The light blue represents all splits?

THE WITNESS: Yes, Your Honor.

JUDGE OSTEEN: Okay. And then the lighter purple color is where those two overlap?

THE WITNESS: Correct.

JUDGE OSTEEN: Okay. Thank you.

BY MR. EPSTEIN:

Q All right. So we were just about to get to this histogram on Slide 37 that now is analyzing the 2012 votes using your different collection that only includes those doubly weighted county -- against county splits plans.

A So we've decreased the number of county splits a bit,

quite a bit actually, and we see that there's essentially no change in the qualitative results. The outcomes of the elections are essentially the same. The blue is what we had in our original 24,000, and now orange on this plot is what we had with our ensemble that had lower number -- a lower number of county splits typically.

Q And going to Slide 38, was -- in this new collection, was the box plot structure for the 13 districts similar or different than for the original 24,000 ensemble?

A It's very similar. You see that the median, those lines in the center of the box plots, largely line up very close, and the sizes and positions of the 50 percent boxes are also in agreement.

Q So the last two slides that we looked at, what does that tell you as the mathematical expert about this subject of county splits and its impact upon the redistricting plans that were in your original ensemble?

A It doesn't make any real qualitative difference in the conclusions we reached.

Q Okay. Now, it says -- I'm sorry.

A Pushing the county splits down didn't change the qualitative structure at all.

Q And what does that say about the original results with the higher number of county splits?

A They seem -- they're valid. They have the same

qualitative structure as the new ones.
Q On the bottom right-hand corner of this and the previous slide, it says "2012 votes." Is that the votes that were applied to do this validation work?
A Right, since when we compared the two different box plots -- when we did the comparison before with 2016 and 2012, we didn't see anything different for these validations. We just used 2012 votes, and that was largely --
Q Did you -- we're running out of your PowerPoint here, but I'm going to ask you some questions about things that aren't in the PowerPoint.
Did you do additional work to validate the results that you've shared with the Court that aren't in your PowerPoint but are in your paper?
A Yes, we -- as I --
Q I'm going to get to that.
A The answer is yes.
Q Is that the section of your paper entitled "Testing the Sensitivity of Results," which is at pages 24 through 30 of the paper, Exhibit 3004?
JUDGE OSTEEN: Is that Tab 2 or Tab 4?
MR. EPSTEIN: It's Tab 4.
JUDGE OSTEEN: What pages again?
MR. EPSTEIN: 24 through 30, Your Honor.
THE WITNESS: Yes.

BY MR. EPSTEIN:
Q Okay. And so I'm going to ask you some specific questions about the testing of sensitivity of results you did that we didn't show on the PowerPoint.
Did you test to make sure that reducing population deviation down from 1 percent to the desired goal of 0 percent would not qualitatively affect the outcome?
A Yes, we -- initially, we thresholded at 1 percent. So this is Figure 12 in the paper on page 25. We initially thresholded at 1 percent, but we also then considered thresholding at .75 percent and .5 percent, and you see that decreasing it, there's no systematic effect, there's no change, and if you compare the box plot to the picture to the right, it's a little bit more -- it's a more informative version of the box plot. It actually shows the histogram, the PDF on each of them, so it even gives more information, and, as you see, the green and the blue in the figure on the right look almost identical. So it really shows that decreasing the populations, the compliance with the population equal partition, didn't change the results.
Q Did you test to make sure that changing the compactness threshold, that is how compact the individual districts had to be to make it into your ensemble -- how that qualitatively affected the outcome?
A Yes, so if you turn to the next page, page 26 in Figure

13, we did the same exercise again. We said let's -- so here we're talking about the isoperimetric score, which is a smaller score, which means it's more like a circle and less elongated like a wiggly hot dog, and as it decreases from 80 to 60 to 54, and even when we had absolutely no thresholding, the results looked very similar, qualitatively the same.

Q Did you test to make sure that changing the compactness energy, as you call it, would not qualitatively affect the outcome?

A Yes.

Q First of all, define what you mean by compactness energy?

A So in our score function, there were different terms that measured how well a particular district adhered to the design that the nonpartisan design criteria laid out in House Bill 92. One of those was the compactness; that is to say, how much it looked like a circle. Initially, we use the isoperimetric constant, which is the ratio of the perimeter of the districts squared over the area, but sometimes in the bill, they also talk about other measures, and we considered a different measure, which was looking at it in a box, a rectangle, which included the district, and comparing the two areas. So that's a very different measure, but, in fact, it gave qualitatively the same results. So it was not sensitive to changing what our definition of compactness was.

Q Dr. Mattingly, when you began the Markov Chain Monte Carlo

algorithm to start producing Maps No. 1, 2, 3, and 4, in what ultimately became over 24,000, was there some kind of geographical starting point so the computer knew how to start the process?

A Yes. The way the algorithm works is it starts with an initial map, and then it manipulates and fidgets the boundary in a way that preserves this measure. So in the initial run of 24,000, we started from the Judges map.

Q The Beyond Gerrymandering map?

A The Beyond Gerrymandering map, but we also --

Q Let me just ask you before you go there, how do you know that that initial starting condition didn't skew the outcome in favor of plans that looked like the Judges Plan and against plans that looked more like the General Assembly's plans?

A It's a legitimate question, and so we tested against that.

Q Where at?

A All right. I am searching.

Q Is that page 28?

A You are correct. It is page 28. So if you look at page 28, Figure 14, the top -- the top set of figures across the top, we considered where we started from the Judges Plan, where we started actually from the NC '12 map, and where we started from the NC '16 map, and you see they look very, very similar. There is a small amount of fluctuation, but that's attributed mainly to the fact that we used lower numbers.

Q Okay. And so if you had instead started with the 2012 Plan or the 2016 Plan, what is this chart in the upper left-hand corner of page 28 telling us about what kind of different results would have been obtained?
A We would have obtained the same conclusions, especially when you look at the box plot just to the right, and the same thing, you see that they line up identically. So all the qualitative descriptions we've made about these S curves and deviations impacting, they would have all -- the same conclusions would have been made if we had started from the legislative maps as the initial condition.
Q Finally, did you do some validation work as it relates to the topic of weighting of the criteria?
A Yes, we did.
Q Is that the chart -- Figure 16 at the top of page 30?
A Thank you, yes.
Q Okay.
A So we made --
Q Briefly describe what it is you were doing in this chart and what you were validating.
A So there was some choices. We had to tune some parameters to make the maps look basically like the maps we saw already having been produced, the 2012, 2016. We wanted them to have reasonable numbers to county splits when compared with them, reasonable compactness when compared with them, reasonable

population deviations given what House Bill 92 said; but then we wanted to say, well, what if we had changed those weightings? So we moved up and down around -- we moved up and down each of these weightings, and we chose different weights and sought to change the result. If you look, we have this box plot. This is Figure 16, and you'll see that, again, all of the boxes line up essentially in the same position. There's some small fluctuations, but they're largely the same, the positions where they showed -- where they end up.

Q And what does that tell you about the weighting that was used in the actual ensemble, the 24,000?

A That the conclusions we're drawing are not particularly sensitive to the exact details of how we built this ensemble.

Q Okay. You used 2012 votes for the various validation work that we just went through, is that correct?

A That is correct.

Q Why did you use 2012 votes for those?

A Well, as I explained, we were doing this as part of this Beyond Gerrymandering Project. So we initially had a presentation in early -- in November, and so the validation is something we do very early on to make sure that you have things going the way they should be going. So at that time, we didn't have 2016 votes yet.

Q Okay. And that's why you used that in your paper?

A Correct.

Q All right. We're going to go forward to the last slide, which is Slide No. 39 in your PowerPoint. The first question I want to ask you before -- are these -- have we seen these two slides before?
A We have. These are just repeats.
Q Are they now side by side the comparison of the 2012 Plan to the ensemble of yours and to the Judges Plan and then the comparison to 2016 Plan to your ensemble and to the Judges Plan?
A Yes.
JUDGE BRITT: Does that appear in the chart -- in the exhibit?
MR. EPSTEIN: It appears, Your Honor, in the PowerPoint that we gave you, which is Exhibit 3040. It's the last page.
JUDGE BRITT: I got it.
MR. EPSTEIN: Thank you.
BY MR. EPSTEIN:
Q So the first question I want to ask you: In looking at this particular slide, is what it tells you about whether a need to comply with the Voting Rights Act or to have two districts that have high percentages of African-American voting-age population requires the drawing of a -- of districts in a way that provides a significant advantage to Republicans?
A Well, our ensemble already had that as part of its

construction. From all of our maps, we had these criteria so they complied with the Voting Rights Act. When you see that typically we get this yellow line, and then the judges, when they drew their maps, which also complied, produced the green line, and so there's no -- there's no -- there's nothing in that that necessitates a structure which would give this S-shape and these packing here and these depletions here, and I should be careful. When I say "here," I mean in the first three to the right on the left-hand panel and the first three to the right on the right-hand side panel, and then the next three in from those three on both panels being depleted, being below the box plots.

Q And let me ask that question in a slightly different way.

What does this slide tell you about whether the need to comply with the Voting Rights Act or to draw two highly populated African-American voting-age population districts could explain the partisan distribution of congressional seats resulting from the 2012 and 2016 Plans and elections?

A It doesn't explain it.

Q All right. Now, Dr. Mattingly, you told us earlier when we started that you began this project with Ms. Vaughn before Mr. Speas ever knocked on your door, trying to figure out if the political geography of North Carolina and the distribution of where voters lived in North Carolina, whether they be Democrat or Republican, could by itself explain the partisan

outcomes of our congressional elections during this decade.

Did you figure out the answer to that question in the work that you've been describing to the Court today?

A We did.

Q And can you use those -- that slide and those graphs in front of you to explain your answer to that question?

A Yes. So by using this ensemble of 24,000, we discovered what the background structure in the geopolitical makeup of North Carolina is, its geography, where its people live, where its voters in each party are distributed, and where the African-American population is, and what that necessitates relative to the Voting Rights Act. And what we see is -- this yellow line and these set of boxes shows what we typically see when we draw in a nonpartisan way, and as you can see, that's very different than this type of packing, this packing here to the most three right in each map, and then this depletion of voters in the next three. That's a very different structure than what one would see just based on the geography and the geopolitical distribution of people in North Carolina.

Q And, Dr. Mattingly, if it's not the political geography of North Carolina that explains the results of our congressional elections over the past decade, what, in your opinion, does explain those results?

A Well, we did another analysis where we looked at the boundaries of the maps, the boundaries of each of the

districts, and we moved the boundary around 10 percent, and we saw that drastically changed the outcomes, the makeup of these districts, and we found that it did for the 2016 and 2012 maps, and it didn't for the Judges. So that seems to say that it was not just randomly chosen from a map that looked like that. It was very specifically tuned.

Q And specifically tuned to do what?

A To develop this type of partisan advantage.

MR. EPSTEIN: Those are all of my questions, Your Honors.

JUDGE OSTEEN: Cross-examination?

MR. STRACH: Yes, Your Honor, thank you.

CROSS-EXAMINATION

BY MR. STRACH:

Q It's still morning. Good morning, Dr. Mattingly.

A Good morning.

Q I'm Phil Strach. We met a couple of times at your depositions. This stuff is fairly complicated, so I'm going to try to keep it as simple as I can keep it, but if I oversimplify something, let me know, okay?

A I will.

Q You've already told the Court this is your first time acting as an expert witness, is that right?

A That is correct.

Q And other than the redistrictings that are generated by

your computer, you've never sat down with redistricting software and drawn an actual map, have you?
A No, I haven't.
Q And are you familiar with a redistricting software called Maptitude?
A I've never used it. I've heard of it.
Q Okay. The article that you have published that you've been talking about here today, has that article been peer-reviewed?
A It's not. It's not yet been published.
Q It's not been peer-reviewed or published?
A It's -- no, it's not been -- well, it was under review, but it's never been published, no.
Q So it's never -- other than being on the internet with that e-archive, I think is what you called it, it's never been reviewed or published in any academic journal?
A No.
Q Let me just focus on one particular underlying assumption that I want to make sure is clear about your work --
JUDGE OSTEEN: Hold on, Mr. Strach. I may have messed up. Is there any further direct examination?
MS. EARLS: Thank you, Your Honor. I would have jumped up then. Thank you.
JUDGE OSTEEN: All right. You may continue. Sorry about that.

MR. STRACH: Thank you, Your Honor.
BY MR. STRACH:
Q So let me focus in on something fairly basic, I think, that I want to make sure is clear. When you tell your computer to generate these redistricting maps, you take votes from the 2012 and the 2016 elections, and then you change the districts assuming that the votes would remain the same for the political parties from those elections, correct?
A Correct, we tabulate the votes in each district as they were cast, Democrat or Republican.
Q All right. So the analysis that you've done just has a baseline assumption that voters vote for the party and not for the particular candidate, correct?
A Yes, and we -- yes, we validated that.
Q Right. Well, but you agree -- you agree, though, that in actual fact, voters don't always just vote for the party, they also vote for the candidate?
A Yes, they do, but we actually looked into whether that held in these maps.
Q And in the -- you agreed in one of your reports, though, that assuming that voters vote only for the party and not the candidate is not always a valued assumption, correct?
A Right, but then we went on to validate that after that, yes.
Q So if you assume that voters vote only for the party when

they go in to vote, then your analysis does not take into account the dynamics of each election, is that correct?
A So we did actually address that. So what we did was we looked at -- we actually collected and used other elections. So after we wrote this paper, we looked at -- because we were curious about exactly this point, and we looked at a number of different elections, including Senate races and presidential races, and it may affect the qualitative -- it doesn't affect to any extent the change in any of the results here. The qualitative structure of all the plots that I showed you stays the same, and that, therefore -- thereby controls for whether it was an incumbent or whether it wasn't an incumbent or whether it was the personality of the candidate.
Q All right. So you didn't, though -- you were using statewide voting data for your analysis, correct?
A Which analysis? The analysis here or the analysis I just talked about?
Q Both.
A I was using sometimes statewide, but also different -- I mean, we used legislature, we used President, we used Senate, yes.
Q You didn't do any study of, say, the dynamic of the 2016 race for the 10th Congressional District, including looking at the candidates and fundraising, did you?
A No, we did not.

Q And, in fact, you didn't do any analysis like that for any of the congressional districts individually, did you?
A No. Since our districts moved around, it really wouldn't make sense to do that.
Q Now, let me try to understand and make sure the Court understands exactly how you selected and got down to the 24,000 redistrictings that formed the basis of your analysis. And I assume that your analysis is based on this 24,000-plus redistrictings that you generated, correct?
A Correct, and then validated against the 120,000.
Q Right. So is the first thing that you did was you asked your computer to generate every possible redistricting -- congressional redistricting that could possibly be generated, is that correct?
A No.
Q What did you do?
A We first put a distribution on redistrictings that weighted districts -- redistrictings according to how well they satisfied the redistricting criteria, and then we sampled from that distribution, drawing redistricts according to how well they satisfied the redistricting criteria, and then after that, we made a second thresholding just to remove any that were large deviations away.
Q Right, and I understand. I'm going to actually get to that part. I'm starting even further from the beginning.

A Right.
Q Okay. So I'm like in genesis. You're like into the Judges right at this point. I'm going to start with genesis, if that's all right?
A That's fine. So in terms of your analogy, in terms of genesis, we didn't create all bacteria and all organisms. We started off with humans. We first sampled from a certain distribution.
Q Right. You told me in your deposition, right, that if you tried to create -- if you told your computer to generate all possible congressional redistrictings in North Carolina, that's just some astronomical number?
A Yes, that's correct.
Q Right. And you don't know that exact number, do you?
A It depends. You have to tell me what your assumptions were. If you wanted to make sure they were contiguous, if you didn't --
Q If they're not contiguous?
A I think actually in the paper there was a number to that. I don't have memorized it. If you have it in front of you, I'm happy to validate it.
Q I just recall it was an extremely astronomical number, correct?
A Yes, but that would allow the 13th District to have something, you know, out at the coast and something in the

mountains.
Q That's right. And that's why it's such a big number?
A That's why it's such a big number.
Q So from that, what you did is you asked the computer to at least generate contiguous districts, is that correct?
A Correct. Correct.
Q Okay. And it's that set of districts that you called in your paper the Set R, is that right?
A Yes.
Q Now, do you know of that Set R -- this is all of the number of contiguous districts that your computer can draw for North Carolina's 13 congressional districts. Do you know how many redistrictings were in that Set R?
A It's hard to say exactly. It's a difficult problem.
Q Okay. I mean, it could be a million? It could be a billion? I mean, you just don't have any idea?
A I would have to sit down and try to calculate, but I would say -- I mean, it would be more than a million for sure.
Q All right. And I take it then, based on your testimony today, you haven't sat down to try to calculate what that number is?
A No, we were interested in sampling from this distribution of districts -- redistrictings that satisfied House Bill 92, so that's what we were drawing from.
Q Right. And I just want to make sure because I think it's

important that we know what you started with to begin with, all right?
A Right.
Q And so sitting here today, the set of redistrictings that you used to created the 24,000 to sample from or whatever, you don't know what that number is?
A Well, that's not really the way to think about it, I think, to phrase it right. I think the way to think about it is we first put a distribution on districtings that satisfied House Bill 92, and then we sampled from that distribution on redistrictings. We didn't treat all districtings likely -- equally well because some redistrictings don't satisfy House Bill 92 to the same extent or even at all.
Q I understand that, and I'm going to get to that in just a moment, I promise.
So what I'm focused on right now is the Set R, which is the set of contiguous districts. And you don't know that number of redistrictings, correct?
A Correct.
Q Then from that Set R, is that the set from which you ran the Monte Carlo sampling to get 150 redistricting plans?
A 150,000.
Q I mean, 150,000?
A Yes, we then sampled from that Set R based on the distribution we had put on it.

Q All right. Now, so you got 150,000 redistricting plans out of this unknown number of R -- Set R redistrictings. So we don't know what the percentage of the Set R that 150,000 equals, correct?
A Correct, but we do know that we sampled the distribution well and captured its characteristics.
Q Okay. So if you're imagining a continuum in your mind that started off with all those unconnected redistrictings, that astronomical number, and then continued down to the Set R from that, which we don't quite know how many that is, and then we carry on to the 150,000 that you got, we don't know where on that continuum that Set R is, do we?
A No, we don't.
Q All right. So then what you did is once you got --
A I would say that what you said so far really isn't germane to what we did, but I'm answering your questions.
Q Thank you. I appreciate that.
Once you got the 150,000, was it against the 150,000 plans that you then did I think what you've called your thresholding?
A That's correct.
Q All right. And is it fair to say that when you say thresholding, what you mean is you're applying -- you're telling the computer to now apply the criteria that you've picked?

A No, in drawing the 150,000, we already applied the criteria. Those were based on -- so the idea is that every time we draw a redistricting, we're drawing it with more likelihood. We draw districts that satisfy -- the better a district satisfies House Bill 92, the better it has low compactness, the better it has low county splits, the better is it splits the population equally, it's more likely to be drawn. So we first drew 150,000 that was drawn from that distribution and then -- just to make sure, but there are some that don't satisfy it very well. They were very unlikely, but when you draw 150,000, you draw some unlikely things.

So then we removed by thresholding those ones that were outside some minimal -- some absolute minimal standards that we placed.

Q Okay. So your thresholding was a more specific way to apply the criteria that you wanted to apply?

A Well, within the ones we had drawn that were more likely or less likely based on how well they satisfied the criteria, it got rid of some that were absolutely not reasonable, absolutely not likely complete, you know.

Q All right. And once you applied your thresholding process, that's when you got down to your 24,000 redistrictings from the 150,000, is that correct?

A That's correct.

Q All right. Now, when you did this analysis, I believe it

was in 2016, the 2016 Congressional Plan had already been enacted, is that correct?
A I believe so, yes.
Q I think you said you started this around May of 2016?
A Yeah, that's correct. Yes, you're right.
Q Okay. So if you wanted to apply thresholding using criteria that could be observed in the 2016 congressional map, you could have done that, correct?
A Yes.
Q You didn't do that, correct?
A No, we largely used the 2012 as our thresholding because we were just looking for an extreme upper bound.
Q All right. And you used the criteria as it was worded in this House Bill 92, correct?
A That's correct.
Q Rather than using criteria that you could observe in the 2016 map, correct?
A We did apply -- we did take some parts from the 2016 map. We took the level of the VRA from the 2016 map.
Q Okay. All right. We'll talk about that. Now, you wanted to use the House Bill 92 criteria because it was consistent with that Beyond Gerrymandering Project that you were helping, correct?
A Right, that was the reason we did it. We had used it -- some of those results -- we'd used them similarly the year

before, but we locked on to it that year because we wanted to interface with the Beyond Gerrymandering Project.
Q So it would've been possible for you -- for purposes of this case, you could have ditched the House Bill 92 criteria and you could have just said, hey, I'm just going to look only at the criteria that were adopted and observed in the 2016 Plan, and you could have limited yourself to that criteria, correct?
A Well, we were interested in nonpartisan criteria. So if you remove the partisan criteria from that, you essentially arrive at House Bill 92, I believe.
Q All right. We'll talk about that.
MR. STRACH: If I may approach, Your Honor?
JUDGE OSTEEN: No need to ask.
BY MR. STRACH:
Q Dr. Mattingly, what I've handed you is a paper called "Toward a Talismanic Redistricting Tool, a Computational Method for Identifying Extreme Redistricting Plans." Do you see that?
A Yes.
Q And the authors are Wendy K. Tam Cho and Yan Y. Liu. Are you familiar with either of those authors?
A I've never met them. I've seen their work.
Q Do you understand that these two authors have published numerous articles in this area of using computational methods to identify gerrymandering?

A I think they have similar numbers to us, yes, but if they've published a few, yes, they have.
Q All right. And this appears to have been published in 2016. Did you review this particular article when you were preparing your report?
A By "review," you mean did we look at it?
Q Yes.
A Yeah, we looked at it -- oh, when we prepare our report -- I mean, we looked at it along the way in preparing our paper, yes.
Q All right. If you would turn to page --
A I should be careful actually. I'm not sure if we looked at this exact one or one of her previous ones. I know I've looked at her work.
Q Can you tell me if you've looked at this exact one prior to finalizing your work in this case?
A I can't be certain if it would be this exact one. What date was this published?
Q It just says 2016.
A She has another paper in machine learning or a genetic learning algorithm paper journal which I looked at. I don't remember if I exactly looked at this one.
Q Okay. If you would turn to page 354, you'll see the numbers at the top of the page. Do you agree that these authors study methods similar to what you've used in this case

in terms of using these simulated maps?
A They used simulated maps. The method for drawing them is very different.
Q Okay. All right. If you look on page 354 on the right-hand side of the page, the first full paragraph starts with "in addition to." Do you see that?
A Right-hand side, yes, "in addition."
Q It says: "In addition to creating a set of possible maps where the underlying population is constant, the maps and the baseline comparison set need to be a fully balanced comparison set of plans, meaning that they balance and consider the full set of relevant redistricting criteria." Do you see that?
A Yes.
Q Dr. Mattingly, do you agree with that statement as applied to this type of research?
A It seems rather vague. I don't quite know what it means.
Q All right. At the bottom of that paragraph, the authors state that "On the other hand, when the full set of criteria are not considered, the produced comparison set is substantively less interesting and perhaps substantively uninteresting." Do you agree with that statement?
A Perhaps. Perhaps it might be.
Q Dr. Mattingly, what I've handed you is an article entitled, "Revealing Preferences Why Gerrymanders are Hard to Prove and What to Do About It." Do you see that?

A Yes, I do.
Q And it has as authors Micah Altman, Brian Amos, Michael P. McDonald, and Daniel A. Smith. Are you familiar with any of those individuals?
A I'm not.
Q And so I take it you haven't read any of their work in this area?
A I don't recall. I may have. I would have to look at the bibliography.
Q All right. Have you read this specific article at any point?
A I don't recall it.
Q Okay. All right. If you'll look at page 25, there's a section called "3.5, Method of Post-Hoc Comparison," and in the second paragraph of that section, they say that "Here, we assess the class of gerrymandering detection methods that compare an adopted plan to plans that are generated post-hoc to the redistricting process."
Would you agree that the work you did is in this genre of research?
A I haven't read the whole thing, so it's a little hard to know exactly what they mean, but we did it after the redistricting process, if that's what you mean, yes.
Q All right. And so if you look at the last sentence of this paragraph, it says: "An important consideration is that

to make proper inference of intent, a post-hoc plan must incorporate the relevant information that led to the agent state -- the redistricting data, the observable process, and public plans -- minus the illicit intent."

Do you agree with that?

A No.

Q Why not?

A Because if I ask is it -- how likely is it for you to stumble upon a plan and without using intent, and I showed that it's extremely unlikely for you to stumble upon it, without having -- without actually looking for it, without actually designing it, then it seems that I've shown that you must have been driving there.

Q All right. Now, why don't you turn to page 28, and at the top of that page, the authors state: "Second, there may be a good reason why an Authority did not explore fair options: because they do not conform to all legally required criteria. Some automated approaches attempt to draw only contiguous, compact, and equal population districts," and do you see that they cite your work there?

A I do. Let me just -- for benefit of the Court, let me clarify that. That's a very earlier work and not nearly as nuanced as the one that came -- the two works -- the work that came two generations later, but, yes, I agree with what you said.

Q All right. This goes on to say that "One can only draw inferences how an adopted plan deviates from plans drawn in accordance to these criteria. In survey research this issue is described as an incongruence of the sample frame to the population of interests, a situation that can produce biased estimates." Do you agree with their statement there?
A Let me read it myself.
So what they say is that one can only draw inference from plans that deviate with those plans drawn in accordance with those criteria, which means that since we used the criteria from House Bill 92, it's exactly what we've been saying all along. We're just deviating -- deciding whether something would deviate from a plan that one would typically see in House Bill 92.
Q So you agree with the statement that I just read?
A I agree with the statement that if -- you know, it's hard to take a sentence out of context right in the middle of a paper, but if this is saying that we just -- our plans were asking if something would deviate from a plan that was drawn by nonpartisan only using the criterion in House Bill 92, yes, I agree.
Q All right. Well, let's look at the next sentence. It says: "Automated algorithms that do not generate districts in accordance with all legally required criteria present in the observable process, minus the alleged illicit intent, pose the

wrong counterfactual question and cannot be used to make inferences of intent."

Would you agree with that based on the work that you did?

A No. I think that you -- I think you would have to be more precise about which things you think are not -- which criteria we're not satisfying for me to actually answer that. I think it would have to be a little more specific, your question.

Q Okay. But you would agree that based on the scholarly materials that we've been looking at, which criteria you end up using to run through your algorithm are very important, correct?

A Of course.

Q And those -- the criteria that you choose should try to be as consistent as possible with the criteria that the legislature actually used in the enacted map, is that correct?

A I think we've been very explicit to say we used the criteria in House Bill 92.

Q All right. And you've also agreed with me that by the time you did your research, the 2016 Congressional Plan was enacted and you could have looked at the criteria in the map itself, correct?

A In the map or in what the legislature said? I don't know what the criteria in the map means. That's what's confusing to me a little bit.

Q Okay. We'll talk a little bit more about that then.
Now, you mentioned earlier -- you understand that the 2016 Congressional Plan as enacted only split 13 counties, is that correct?
A Yes, I believe that was true and the Judges split 12 and the 2012 split 40.
Q All right. Was there -- wasn't there an initial part of your study that you did where in your 24,000 -- set of 24,000 redistrictings, none of your redistrictings split less than 14 counties?
A Yes, in the initial one, but not in the second one.
Q So your initial run produced no redistrictings that had less than 14 split counties, is that correct?
A Yes, we looked at the 2012, and we thought that was a reasonable number in light of that.
Q Right. And then you tweaked your -- and then you tweaked your study, and you were able to get some of the 24,000 that did contain less than 14 splits, correct?
A Not of the 24,000. We created a new ensemble by changing our distribution so that it was centered more on -- it cared more about not splitting counties, and when we did that, we produced I think it was around 15,000 or 14,000, which didn't split as many counties, and the results didn't change.
Q All right. But suffice it to say, though, that in the first set of 24,000 that you ran, you didn't have even one set

of redistrictings that split less than 14 counties, correct?
A We didn't have very many.
Q And isn't it fair to say that if you're trying to make an apples-to-apples comparison here, you'd want redistrictings that were generated by your computer that at least had the same number of split counties as the enacted plan, correct?
A I don't think that that's necessary.
Q You don't think that that's necessary?
A It doesn't have to have the exact same number. We were following the House bill, which said that one should try to minimize that within some reasonable amount, and given what had already been put forward by the legislature itself, it seemed that since the previous plan had 40, this seemed something around the high 20s, low 20s seemed quite reasonable, and then we had a second set, which was much lower, which had a number which were 13.
Q Right. So let me try to ask it this way then. When you did your -- when you were running your algorithms, you knew at that time that the 2016 Plan split 13 counties, right?
A That's correct.
Q Okay. So isn't it true that you could have told your algorithm to limit itself to calling out redistricting plans that only split 13 counties?
A Yes, we could have.
Q And did you do that?

A No, we did not.
Q So you have no idea how many simulated maps that would have produced, do you?
A I think it's not about the number. It's about sampling the distribution and whether the qualitative structure changes. When we made a new distribution which significantly lowered the number of county splits, we saw no qualitative change in the results. So it seems a bit of a red herring. When we pushed it to lower the county splits, it didn't change the qualitative structure of our outcome at all.
Q Okay. But you never -- I mean, you could have -- you could have at least tried out running an algorithm that just pulled 13-county split plans, correct?
A We could have.
Q And you just didn't do that, correct?
A No, we did not.
Q So we have no idea what your conclusions would have been had you done so, do we?
A We have a pretty good idea. We saw that when we reduced the number of county splits down, it had no significant effect on the results, and we had a number that were in that range, and the judges produced one that had 12, and their results lined up perfectly with our statistical ensemble. So they had 12. So I think we have a pretty good idea.
Q All right. But based on your assumption from an ensemble

plan that contained numerous split counties, not just 13, correct?
A Yes, some 14, 15, 16.
Q Some in the 20s, some in the 30s, right?
A Correct, in the first ensemble. In the second ensemble, I don't think we had anything as high as 30. I would have to check. I can if you want.
Q Did -- you understand, don't you, that the 2016 Congressional Plan contained no population deviation between districts, correct?
A Correct.
Q And when I say "no," I mean zero, right?
A Correct.
Q And, nonetheless, however, in your set of 24,000 redistrictings, none of those redistrictings have a zero population deviation, correct?
A That's correct.
Q Now, isn't it true that you could have told your algorithm to limit itself to plans that contained zero population deviation?
A It's not really in the spirit of the type of algorithm, but we saw from our experience in the Beyond Gerrymandering and also looking at some of the numbers, once we got down to below 1 percent, and many of ours were much, much below 1 percent, they were in the, I think, .25 percent deviation -- then once

you were at that level, it was just very simple to do a small hand change to reduce it to zero repopulation, which is, in fact, how the judges did it. They got down to within 1 percent and then afterwards, using a finer level structure, moved boundaries around, and none of these made any of changes in the qualitative structure of their maps.

Q But you didn't run even one algorithm that told the computer to generate only zero population plans, correct?

A No, that's not true. We did look and see if we were to zero out exactly the Judges or exactly zero out the other maps, because when you look at them only at the VTD level, they have a small variation. We looked and saw whether -- if you were to zero them out in the worst-case analysis, whether it would change any of the results, and it would not. So it wouldn't change qualitatively where they were. So we didn't do that with the 24,000, but you'd expect, since they fluctuate on either side in an equal number, that the median effect would be negligible and zero.

Q Okay. But that's part of what you recall in your sensitivity analysis, correct?

A Correct.

Q That's not what I'm talking about.

A Right.

Q I'm talking about something different.

A Okay.

Q What I'm talking about is on the front end, isn't it true that you could have told your algorithm to only choose redistrictings that had zero population deviation? Couldn't you have done that?
A No.
Q You couldn't even have done that?
A No, usually -- if you're doing it at the VTD level, you first do it at the VTD level, and then you're going down to the census block level to zero it out.
Q But your algorithm couldn't have done that for you?
A Not as it was used then.
Q Okay. So there was no way for to you run a comparison set of redistrictings that had only zero population deviation on the front end, not in your sensitivity analysis, but on the front end?
A No, but we could assess after the fact whether doing so, zeroing them out, would have any effect, which is what we did.
Q Now, by the time the 2016 Plan had been adopted, you were aware, weren't you, that -- well, let me ask you this: Were you aware of the prior 12th Congressional District and it looked kind of like a snake? Are you aware of that?
A Yes.
Q Okay, good. And so then once the plan was enacted, you would have seen from a visual review of the plan that that district was no longer like that, correct?

A Correct.
Q And that district was completely confined to Mecklenburg County? Did you -- were you aware of that?
A Which, the new 12th?
Q Yes.
A Yes, I believe I was.
Q All right. And I believe it's true, isn't it, that you could have told your algorithm to only -- to confine itself to redistrictings which had the 12th District or at least one district wholly confined to Mecklenburg, isn't that correct?
A Yes, one could.
Q And you did not do that, right?
A No, we only followed the criteria in House Bill 92.
Q Right. That's right, but you did not follow a criteria that said, hey, keep one of the districts in Mecklenburg?
A That was not in House Bill 92, that's correct.
Q Okay. Then you were also aware, weren't you, that the legislature adopted a criterion in the 2016 Congressional Plan that made an attempt to not pair incumbents? Were you aware of that?
A Yes, I believe so.
Q And when I say "not pair incumbents," do you know what I mean?
A Yes, have them run head to head, if that's what you mean.
Q That's right. And you could have told your algorithm to

only pick redistrictings where each incumbent was in a separate district, correct?
A That's correct, we could.
Q And you did not do that, did you?
A Right, that was not in House Bill 92.
Q Okay. So we don't know what the results or what your conclusions would have been had you done that, do we?
A No, we were interested in seeing what the geopolitical structure of North Carolina would give as a background, as a default signal. So we didn't want to do partisan things like that.
Q Do you recall at your deposition when we were talking about a concept called a traversal?
A Yes, you explained it to me.
Q And a traversal is when a district comes into a county -- crosses a county line, correct?
A That is correct.
Q And we talked about the concept of a double traversal?
A Correct.
Q And the double traversal is when a district crosses into a county twice at two different places?
A That's correct.
Q And you're aware, are you not, that the 2016 Congressional Plan, as enacted, contains no double traversals?
A You told me that at the deposition.

Q And do you believe that to be true?
A I took your word for it.
Q And I believe that you could have instructed your algorithm to ensure that there were no double traversals in the maps that it generated, correct?
A We could have added a square function that would have penalized double traversals, yes.
Q And you didn't do that, correct?
A We did not. It was not in House Bill 92.
Q And then, as it turns out, there were -- your maps did generate some double traversals, correct?
A Yes.
Q You talked about the Voting Rights Act, and I think you agree that in the actual 2016 Plan, there's one district that has a BVAP of 44.46 percent or some change, correct?
A That's correct.
Q And then there's a second district that has a BVAP around 36 percent?
A 36.2, I think, something like that.
Q Now, this is an area where you did look at the 2016 Plan and take some criteria from it, correct?
A Yes.
Q Okay. But when you were setting your thresholds, you set them at -- well, remind me, where did you set your thresholds?
A I believe it was 44 and 33 1/2 for the first most

African-American and the second most African-American district. May I remind you that those are just the thresholds where we cut off. We actually tuned the thing to be centered around the same value as was in the 2016 Plan.
Q Is there a reason why you didn't just go ahead and pick -- set your thresholds at 34 percent and 36 percent, why you chose to go slightly lower?
A It seemed reasonable to have some fluctuations around on either side. It was a choice.
Q All right. And I assume you never did the analysis using 36 and 44, did you?
A What do you mean using 36 and 34? You mean --
Q You set your thresholds at 44 and 33, I think, is that correct?
A Say your numbers again. We set the thresholds at 40 and the lower threshold at 33 1/2, but we centered it around 44 and change and whatever -- 36 and .2, whatever was in the 2016 map.
Q Oh, I see. So your one threshold was actually -- the lower bound was 40 percent, correct?
A Correct.
Q And the high bound was --
A It may have been 39.5. I would have to double-check.
Q So somewhere around 40 percent, correct?
A Yes.
Q And your high bound on that one was the 44 percent,

correct?
A We didn't put a high bound. There was no high bound. We just put a lower bound. We put a lower bound on the most African-American one -- so, first of all, we centered the distribution so that the most -- if you look on Figure 9, it actually shows you the distributions. So we centered it so that it would be centered around -- typically around the two values in the 2016 Plan, but then we put a lower bound. We didn't accept anything that had less than 40 percent and nothing less than 33 1/2, I believe. It's written here, yes.
Q Did you have a higher bound?
A No, we had no higher bound.
Q Now, if you had required your algorithm to pull only plans with zero population deviation, isn't it true that -- well, that would have reduced the number of redistricting simulations that you could have generated?
A I mean, we didn't design our algorithm to produce zero percent population deviation. We're talking about a different algorithm. So it's a little apples and oranges. We could take a given district and ask what -- taking it down to zero, what change it would cause, but that's not the same as what you asked.
Q That's right. If you had -- if you had told the algorithm to just choose redistrictings with zero population deviation, then that certainly would have increased the number of

redistrictings in your simulation set that split counties, wouldn't it have?
A As I said, it would not really be possible in the way we designed the algorithm to go to zero in the algorithm. That would be a different algorithm. We would have to do something different. So it's a little too hypothetical, your question.
Q All right. If you had told the algorithm to only choose redistricting plans that had one district at 44 percent and one district at 36 percent, then that would have reduced the number of plans that your algorithm would have generated, correct?
A Presumably. If you tell me to select a subset of the set, then I'm always going to have less numbers.
Q Now, Dr. Mattingly, I want to talk about the -- what you called the Judges map. Under your analysis, as I recall from your testimony, the map produced by the judges would elect nine Republicans and four Democrats using the 2016 Data, correct?
A I believe so, yes. Let me double-check. 2016? Yes.
Q And so let's look at your Slide 20. Do you have a little set of slides up there?
A I don't have. Could I have a set of slides?
MR. STRACH: Can someone hand Dr. Mattingly the --
JUDGE BRITT: What page did you direct him to?
MR. STRACH: Your Honor, I'm looking at page 20.
THE WITNESS: Yes, I have them now.
BY MR. STRACH:

Q All right. So if you look at the -- I believe you said that the 2016 Plan elected three Democrats. So it would be on the far left-hand side in that column with three, correct?
A Yes.
Q And the Judges would elect four, and that's right there beside it, correct?
A Correct.
Q But the one that most often came up in your simulations was actually five Democrats elected, correct?
A That's correct.
Q So if you look at the difference between where three Democrats falls versus the Judges, I think that looks like a difference of -- you know, it's hard to tell, but it's about 27 percent or so, is that fair?
A Yes.
Q Okay. And then if you look at the difference between where the Judges map fell versus where most of them fell, the column of five goes up to about .55. So you've got a difference of about .55 and about 27 percent -- it, too, is about a 27 percent difference, correct?
A Correct.
Q All right.
A I don't understand the point.
Q So the difference between the number of Democrats that the 2016 Plan produced versus the Judges is about the same

difference between what -- the percentage of what -- the Democrats that were produced under the Judges versus your most common result, correct?
A And the effect of that is that it's twice as likely to get five as it is to get four, but it's 42 times more likely to get four than it is to get three.
Q Right. And so under your analysis, not even the Judges map produced what you would contend to be the most reasonable outcome, correct?
A No, it's only twice as likely to get five as it is to get four, but that's nothing to compare with three, which is 42 times less likely. I mean, you can't compare two times and 42 times.
Q And you said three times versus 42 times?
A I think two times. I mean, roughly speaking. I'm looking --
Q Right. That's what I'm interested in. Between three times and 42 times, in your mind, where does the plan go from being reasonable to unreasonable?
A I don't think I really want to say there's a line. I just want to say that clearly if something only happens in 99 -- in 1 percent of the times, it's an outlier.
Q But if the Court has got to decide where that line should be between three times and 42 times, you can't tell the Court where that line ought to be?

A I think I can tell the Court that this is an outlier, that this is unreasonable.
Q Okay. Can you tell the Court where it becomes unreasonable? At what point on that line it becomes unreasonable?
A I mean, I think that's a question for the Courts.
Q Okay. Fair enough.
Dr. Mattingly, I believe you state in your report that -- and you agree, don't you, that it is reasonable for some amount of politics to be considered in redistricting?
A Very much so. That was the role of the Judges Plan in this analysis.
Q Okay. In fact, isn't it your opinion that it would be contrary to the idea of democracy not to allow some political considerations to be used in redistricting?
A Again, I think that's a question for the Court.
Q All right. And I believe in one of your reports, you reviewed the efficiency gap test, is that correct?
A People were very interested in it, so we, in passing, saw what it did in our ensemble.
Q And you did have a conclusion about the stability of the efficiency gap test, didn't you?
A Right. I think you should clarify what we mean by stability.
Q Whatever you meant.

A I can tell you what I meant, is that okay?
Q Yes.
A What we just meant was that we looked at the Judges Plan, and we had some measures in there that were very stable. They didn't change from the 2012 to the 2016 elections. The efficiency gap changed a bit, but that was just an observation. That's all. It wasn't a condemnation of the efficiency gap on that basis per se.
Q So -- but you concluded, didn't you, that the results of that test seemed to change when one changes the set of votes used in the test?
A For the Judges map, for our two votes.
Q All right.
A I don't really claim to be an expert on the efficiency gap.
Q I did want to follow up, Dr. Mattingly, on one thing, and I believe this is at page 28 of your report.
A Of the report or of the ePrint?
Q Do you still have the report?
A The original report?
Q Yes. Yes. I think you have the one that's got your handwriting all over it?
A That's the ePrint. At page 28, yes, I do have it. It's right here in front of me, please.
Q So I'm looking at page 28 of the report and Figure 14,

which I believe you were testifying about just a little while ago, is that correct?
A That's correct.
Q And I was looking at, I think, the -- you said that this represented some -- I think what you called it was validation work --
A Correct.
Q -- correct? And you used only the 2012 votes only to do the validation work, correct?
A In this report, yes. We later did it for 2016 also.
Q But in this report, which is what we're looking at, you only used 2012 votes, correct?
A In this report, we hadn't done it yet for 2106, but we did that later.
Q In this report, you don't use the 2016 votes, do you?
A No.
Q And you agree with me, though, that the 2016 was a better year for Republicans, correct?
A Correct, but the validation still held. Nothing changed when we used 2016 votes.
Q All right. But that information is not in this report, is it?
A No, we hadn't done it yet. We did that in preparation for publishing the paper.
JUDGE OSTEEN: Mr. Strach, how much longer on cross?

MR. STRACH: Your Honor, maybe a minute or two. I just want to check some notes.

Your Honor, that's all I have.

JUDGE OSTEEN: Redirect?

MR. EPSTEIN: Your Honor, I have about -- I know you're trying to assess the lunch hour. I have about 15 to 20 minutes of redirect. I don't know if you want me to proceed or if you would rather take a lunch break.

JUDGE OSTEEN: Let's take a lunch recess. Do you all want a little bit of time to talk about some more of the witness stuff, or do you feel like we've got enough evidence coming today that you can save that for the evening?

Ordinarily, I'd give you about an hour or a little bit more for a lunch recess in this case, but if you want a few extra minutes to talk, we can do that.

MR. SPEAS: I think not, Your Honor, thank you.

JUDGE OSTEEN: We'll just deal with that. All right. Let's take an hour lunch break and come back at 1:45.

(At 12:37 p.m., break taken.)

(At 1:47 p.m., break concluded.)

JUDGE OSTEEN: All right. Let me clarify a couple of things before Dr. Mattingly returns to the stand. In terms of the deposition stipulations, as I understood it, I may be wrong, we're not talking about filing complete depositions. We're talking about what's been filed in terms of designations

and counterdesignations. Or am I wrong about that at this point?

MR. SPEAS: I thought it was the whole deposition.

MR. STRACH: Just to avoid the process of having to go back and doing more counters and more designations, we thought it would be easier to file the whole thing.

JUDGE OSTEEN: When do you all anticipate the full depositions will be delivered?

MR. STRACH: We can file it whenever the Court would like.

MR. SPEAS: Next week.

JUDGE OSTEEN: All right. Dr. Mattingly is still in the courtroom. Come on back to the witness stand. You're still under oath.

JUDGE BRITT: We only swear you but once. That satisfies. You remain under oath.

You may proceed with redirect.

REDIRECT EXAMINATION

BY MR. EPSTEIN:

Q Okay. Dr. Mattingly, during the cross-examination that Mr. Strach went through with you, he asked you a number of questions about the criteria that were actually adopted by the General Assembly in February of 2016. Do you recall numerous questions of that sort?

A I do.

MR. EPSTEIN: Your Honors, if I may approach the witness with this exhibit, which is Exhibit 1007. I have enough exhibits for counsel tables and for law clerks as well. If I may pass those out?

JUDGE OSTEEN: You may.

MR. EPSTEIN: Thank you.

BY MR. EPSTEIN:

Q Do you have Exhibit 1007 in front of you, Dr. Mattingly, which says "2016 Contingent Congressional Plan Committee Adopted Criteria"?

A I do.

Q Can you show us in those criteria Mr. Strach asked you about where the General Assembly required the redistricting plan to have only 13 county splits?

A It does not.

Q Okay. Can you go to the section on compactness on the second page?

A Yes.

Q And the first time the word "counties" appears I think is on the fourth line. It says : "...of the current districts and...." Can you read what it says after the "and" in that fourth line under "Compactness"?

A "...and keep more counties and VTDs whole as compared to the current...plan."

Q How many counties were split in the current plan that was

referred to in the "Compactness" section of these criteria?
A I believe it was 40.
Q And if you would, go to your article, which is Tab 4 of the notebook, the exhibit notebook, and on the top of page 22 is your Figure 9 that you were referring to earlier, which actually contains two different graphs. The histogram on the right is the same as we looked at earlier in your PowerPoint, correct?
A That is correct.
Q And is that -- the histogram showing in your ensemble of 24,000 the number of counties that were split?
A Yes.
Q Okay. And I think you agreed with Mr. Strach that you had some plans in your ensemble that split over 30 counties. Can you look at that histogram and confirm whether that's an accurate statement?
A If there's any over -- there's a tiny fraction that split 30 apparently, but less than -- definitely less than 1 percent.
Q Okay.
A Not over 30.
Q I believe you agreed with Mr. Strach that there was no plan within your 24,000 that split less than 14 counties. Can you look at that histogram and tell whether that was accurate?
A It's not accurate.
Q So you were mistaken when you said that?

A Correct.
Q Okay. What is the accurate number of plans percentagewise that split fewer than 14 counties?
A It's hard to -- fewer than 14?
Q Yes.
A I mean, that split it all or significant splits?
Q That split it all.
A It's hard to read. It's very small.
Q Okay.
A The light blue is the --
Q And how many of the 24,000 plans complied with the compactness criteria that you just read, keeping more counties and VTDs whole, as compared to the current and active plan?
A All of them. We thresholded at 40.
Q Mr. Strach also asked you about why you didn't tell the computer when you were running your Markov Chain Monte Carlo algorithm to only accept plans that had Mecklenburg County confined to a single district. Do you recall announcing that?
A Yes.
Q Going back to Exhibit 1007, the criteria that the legislature adopted, look at the section on the 12th District on the first page at the bottom.
A Yes.
Q Is there anything in that section about the 12th District that required Mecklenburg County to be within a single district

in the enacted plan?
A Give me a moment to read it. No.
Q Was your 12th District in all 24,000 plans different than the 12th District in the enacted plan as it existed at the time these criteria were adopted?
A Yes, and it was more compact.
Q I was going to say how do you know, without looking at all 24,000 plans, that none matched the existing 12th District?
A Because the 12th District was very noncompact and we thresholded the compactness level to make sure the 12th District would never have passed that thresholding.
Q Was there a single district in all 24,000 plans -- and if you did the math 24,000 times 13, in all of those districts -- was there a single district in your entire ensemble of 24,518 that approximated what the 12th District looked like in the enacted plan after the time this criteria were adopted?
A No.
Q Okay. Double traversals. As best you can, explain to the Court what Mr. Strach was referring to when he was asking you about double traversals in your simulated maps.
A I'm going to use my hands, but I'll try to explain for the record what my hands are doing. If you have a district, there's two places disjoint, that is to say not touching, where a district pokes into a certain county. So that's one traversal, two traversals.

Q And Mr. Strach asked you whether or not you told the Monte Carlo algorithm to reject plans that contained these double traversals and you said you did not. Looking back at Exhibit 1007, the Contingent Congressional Plan Committee Adopted Criteria, which of those criteria indicated that double traversals were unacceptable and could not be employed in a plan adopted by the General Assembly?
A I don't believe the double traversals are mentioned at all in this document.
Q Did the criteria adopted by the General Assembly even require that there be two districts that had a high BVAP or black voting-age population? Did their criteria even include that?
A I believe that the Voting Rights Act wasn't mentioned in here at all.
Q And there were questions about your thresholding of those two districts at 44 and 33 1/2 percent, and I believe your testimony was you chose those numbers in order to center them around a range, is that correct?
A That is correct.
Q Do you actually have a figure in your paper, Exhibit 3004, Tab 4 in your notebook, that shows exactly what the different outcomes were for those percentages within your 24,000?
A There is.

Q Okay. And if you look at page 22, it's actually right next to the histogram we were looking at a moment ago.
A Yes.
Q On the left-hand side of page 22.
A Yes.
Q It says: "Districts ordered by largest AA district." Can you tell the Court what we're looking at in that graph?
A So the bottom axis is the district, so we see the axis goes all the way up to 24,000. So it's in Figure 9, the leftmost panel. And if you -- they were ordered -- all the districts were ordered from highest -- so we looked at the most African-American district, the highest percentage, and we order it from highest to lowest and as you -- so that's the black line at the very top of the plot. Then you see it goes from slightly above -- somewhere in the 36, 37, somewhere in there, and then it drops down just -- I mean 46, 47. Then it drops down to below 45 for quite a while and then it slowly decreases down to 40 percent.
Q Where does 44 percent fall within that range?
A Right in the middle. And then for each of those values at -- for each of the values of the most African-American district, we then also plotted the range over which the second most African-American district varied and we put one standard deviation, so that captured a large chunk of them. If you look at the green, that's the second most African-American district

and it's centered somewhere around 36 percent.
Q And was that essentially the number that you were shooting for based upon what the 2016 General Assembly Enacted Plan actually produced in terms of the second highest BVAP?
A Yes, that was it.
Q You were first asked -- I believe one of the first questions you were asked by Mr. Strach was you made a baseline assumption that voters vote for parties and not the candidate. Do you recall being asked that?
A I do.
Q And do you recall telling him that, despite what you wrote in your paper about that not necessarily being an accurate assumption, you've done more work since then in order to validate whether or not the candidate or incumbency makes a difference to your ultimate results?
A Yes.
Q Tell the Court, if you would, what you did regarding that subject.
A We then looked at a number of different races. We looked at presidential in both years. We looked at the Senate races. We looked at a race from 2014. We looked at different races, and we compared the histograms we got and the box plots that I've been showing you, and qualitatively they had the same structure. There was always a gradual line and then this S-shaped jump.

The point of that -- the relevance to this question is that the incumbency changed or, rather, the candidates changed, many of the things we didn't control for changed, and the result wasn't sensitive to it. It never mattered.

Q And that included the 2014 Senate election --

A Yes.

Q -- where different candidates then ran when the 2012 or 2016 congressional elections ran?

A Yes.

Q It included the 2016 presidential election?

A Yes.

Q We had presidential candidates as opposed to congressional candidates?

A Yes.

Q And what other race or races? A 2016 Senate race?

A Yes.

Q Any others?

A There may have been the Secretary of State.

Q Okay. And regardless of which candidates were on the ballot, when you dropped their votes for those statewide elections into your 24,000 did the box plot structure change appreciably?

A There's also a governor race, at least one. It did not change.

Q And did the S-shaped curve of what the General Assembly

did in 2016 in its enacted plan change?
A No.
Q You were asked about Figure 14 on page 28, which included a number of validation charts, for lack of a better word.
A Page -- which page?
Q Page 28 of your paper.
A Yes.
Q And Mr. Strach asked you, you only did validation work like that for the 2012 votes. Do you recall him asking you about that?
A I do.
Q Do you recall him saying that's not really fair because 2016 was a better Republican year? Do you recall him saying that?
A Yes.
Q And I think you responded that you now have done validation work using the 2016 votes to ensure that the work that you did was stable irrespective of whether you were using the 2012 votes or the 2016 votes, is that true?
A Yes. We redid, for instance, this plot, the plot -- redid a large number of these plots that we had done only with the 2012 votes. We redid them with the 2016 votes and they were again stable.
Q Do you have those charts with us today?
A I believe so.

Q Okay.

MR. EPSTEIN: And, Your Honor, with Your Honors' permission, I have a couple of PowerPoint slides that I would like to have Dr. Mattingly testify to. I think he can do it from the witness stand.

JUDGE OSTEEN: Any objection?

MR. STRACH: May I ask my colleague a question? Your Honor, I don't believe I've ever seen these before, so we're going to object to the use of these at trial.

JUDGE OSTEEN: Sustained if they haven't been turned over. Well, let me see what my --

(Discussion between the judges.)

JUDGE OSTEEN: All right. We'll let them in subject to the objection. We'll decide after we see the charts.

MR. EPSTEIN: Thank you, Your Honor.

If you can get the PowerPoint cued up on the screens. Thank you. Okay.

BY MR. EPSTEIN:

Q This first one, Dr. Mattingly, can you see it from where you are?

A I can.

Q What 2016 -- what were you validating with 2016 votes in this first slide?

A So this is a repeat of what we did for 2012 with the exact same colors, as you recall. We were looking at the low county

splits where we had the second ensemble. We concentrated around much lower county splits, around 14 -- around 14 splits, and that was in orange. Here's the green -- blue again, which is the ensemble with -- all evaluated with the 2012 vote, and the structure is similar. There's some small fluctuations. There's not as many samples, but in particular number three -- the chance of having three is very small. Then the box plots look structurally the same, the same rise in the median. It's pretty much a straight line.

Q The next slide, what were you validating with 2016 votes in this second slide?

A Again, we're now looking at starting from different initial conditions. We're saying we start our algorithm to produce these ensembles. We start from -- the original one was the green one, which was starting from the judges, but then we also started from the legislature's map from 2012 and the legislature's map from 2016. You see qualitatively the results are pretty similar to the level that we're interested and the box plots look the same.

Q And finally, the last slide, what did you do with 2016 votes on this last slide?

A In this last slide, we again did the validation of changing the parameters in our score functions slightly, about 20 percent, around in that neighborhood, depending on the parameter; and we saw that ended up changing qualitatively the

results that we got. Again, since all the results follow from the box plots, the box plots have pretty much the same structure.

Q Okay. And those are the only three slides I have. Dr. Mattingly, based upon that additional validation work you did regarding 2016 votes, what is your testimony regarding the reliability and stability of the 24,000 maps that you used in your ensemble to base the work that you've testified about today on?

A I still state that they're just as valid. They've been validated. They don't seem sensitive to any of these factors from any of the results we've made.

MR. EPSTEIN: No further questions.

JUDGE OSTEEN: Recross?

MR. STRACH: Recross, Your Honor, briefly.

RECROSS-EXAMINATION

BY MR. STRACH:

Q Dr. Mattingly, while we have this PowerPoint up here, when did you do this extra validation work?

A Sometime this fall -- summer and fall. Some of them had been done earlier. Some of them maybe in the spring, some of -- no, no. In the summer and fall.

Q I'm sorry. Summer and fall of 2017?

A Correct.

Q Can you be more precise about when in the summer you did

it?
A I mean, some of them are done at different points. I can't remember exactly when we were preparing the articles and trying to produce more validations to make sure that we were happy with them before we submitted them for publication.
Q So this was work you were doing in connection with preparing your articles for publication?
A Correct.
Q Was it -- would this work have been done after July of this year?
A I believe so. Yeah. Actually, I'm pretty certain. Let me say why I hesitated. There's a lot of plots here and I can't remember if they were all done at the same time.
MR. STRACH: Your Honor, if I may just say for the record, I believe the first trial in this matter was scheduled in June, and this evidence would have never -- obviously wouldn't have even been available at that time. It's not been produced since then. I realize the Court is going to take it under advisement. I just wanted to note that for the record given the testimony.
JUDGE OSTEEN: And the Plaintiffs state succinctly why you think it should be considered?
MR. EPSTEIN: Yes, Your Honor. During the cross-examination, that was an attack on Dr. Mattingly's work, which was: You can't tell us anything about whether or not the

results would have held true for 2016 votes, can you?

And he responded: Yes, I can.

The door was opened at that point. We didn't know Mr. Strach was going to ask him those questions and we had no intention of using any of this information if Mr. Strach hadn't asked those questions.

THE COURT: Isn't that part of his expert work?

MR. EPSTEIN: Well, his expert work will include -- it was, yes, Your Honor. His expert work included validating his results, which was an ongoing process. At the time he submitted his report, this hadn't been done yet, but his work continued. His work continued between the submission of his report and his two depositions, and he handed Mr. Strach the current work as of the second deposition, which was the article that's before the Court today. That was published on May 8, 2000 --

JUDGE OSTEEN: I understand. Do you agree or disagree that Plaintiffs have a duty to supplement expert reports when new information comes in?

MR. EPSTEIN: As a general principle, yes, Your Honor, I agree with that. But we did not intend to use this at all today unless the door was opened that attacked his credibility for the fact he hadn't looked at this question, which is what occurred.

JUDGE OSTEEN: So you hold it back waiting to hear

the cross-examination by the Defendants?

MR. EPSTEIN: Your Honor, unfortunately, we're dealing here with a witness who is preparing an academic work. So his work, as he just testified that he's been preparing, is for this article. It wasn't done for us. We didn't hold anything back.

He's done a ton more work in other cases as well. We haven't produced that because it wasn't work he did specifically as an expert witness in the case. So there would be all kinds of other things that he's done.

But because they attacked his credibility on that specific issue, we believe it was only fair for him to be able to say, well, that's not true, as he did, and then to be able to show what he actually did.

THE COURT: Let me ask something more specific. The last page of his article that's in the book at page 2 says: "The most basic critique of this work is that we have assumed that the candidate does not matter. Furthermore, as districts become more polarized and many election results become foregone conclusion, voter turnout is likely suppressed. While we could try to correct for these effects, we find the simplicity and power of using the actual votes very compelling."

That's a report that's been submitted to the Court. As I understood the testimony, there's been additional work done to test that factor of identity of candidate. Did I

understand that correctly?

MR. EPSTEIN: Yes, except this is not the expert report. So there's a distinction between the expert report and the --

JUDGE OSTEEN: What do you consider the expert report?

MR. EPSTEIN: The expert report is behind Tab 2, which was the state of his work as of March of 2017.

JUDGE OSTEEN: I'm looking at page 23 of Tab 2.

MR. EPSTEIN: Okay. Bear with me, Your Honor. Yes, I see it, Your Honor. It's in the book. So that particular discussion is in both his expert report and his article. Unfortunately, the work that he's been doing, as he described, is for this article. He did not do any additional work for us as an expert witness. And I know that's confusing. I apologize if those lines are very blurry.

THE COURT: If you submit an opinion from an expert that says "we haven't tested this" and then you come to court and you want to present evidence that it has been tested -- which is what happened here, right?

MR. EPSTEIN: Your Honor, respectfully, I don't think that's exactly what happened.

THE COURT: How did you know to ask him the question?

MR. EPSTEIN: In response to the cross-examination question, yes, I know his work has continued because we've

prepared for him to testify.

JUDGE OSTEEN: To ask him about the county maps. It's information he provided to counsel, wasn't it?

MR. EPSTEIN: Yes, to keep us aware of his ongoing academic work, Your Honor, yes.

JUDGE OSTEEN: All right. Anything further?

MR. EPSTEIN: Nothing further, Your Honor.

JUDGE OSTEEN: Further examination?

MR. STRACH: Further cross, yes, Your Honor.

BY MR. STRACH:

Q Dr. Mattingly, I want to turn back to, very quickly, I think it's page 22, Figure 9, under Tab 4, and this is the county split --

A Yes.

Q -- chart -- figure. Your counsel asked you about the number of county splits on the -- near 30, I think. Does this chart report how many county -- how many of your simulated sets had contained 13 county splits?

A It gives the percentage.

Q The percentage. Do you know about what the percentage is based on looking at this chart?

A So you don't mean -- you mean just any split at all, not just a small -- not a sizeable split?

Q Any split, yes.

A Any split. There's a tiny bump there, but not very much.

Q So it would be fair to say that's a tiny fraction of your overall ensemble?
A In this ensemble, not the other ensemble, which is on the next page or a few pages away.
Q Right. And that's one thing I wanted to just make sure is clear. I may not have done a good job with this earlier. You ran one set of redistrictings, an ensemble, in which zero of those redistrictings had county splits less than 14, is that correct?
A A very small fraction at most, yes.
Q Well, I mean, wasn't there some earlier work that we looked at where you had additionally run a set of redistrictings and you had no fewer than 14 county splits?
A I believe so. It's hard to read here. I would say yes essentially.
Q And then you reran another set and that's when you got the number that's reported in Figure 9, correct?
A No. This is the first set. This plot here is the first set to which you just spoke and then the one that we ran again is in the validation section. Bear with me for a second. It will take me a second to find it. It's page 31, Figure 17.
And now in this second ensemble that we ran -- that's the upper rightmost plot on Figure 17 -- you see that there's a fair number that have 14; and when you use those to create the same plots we've been using all along, they get the same

qualitative results.
Q Right. And based on this chart, it looks like the number 13 falls pretty far to the left of the chart.
A I thought we were talking about 14. 14 or 13?
Q Thirteen.
A Thirteen now. Yes, 13 falls to the left.
Q Right. And can you tell me about what percentage or fraction 13 would be?
A Thirteen would be about, I would say, 4 percent and there were about 14,000 maps there.
Q All right. So look back at page 22 of this exhibit because I want to make sure I understand something that you say here. Are you back on page 22?
A Yes, I am.
Q The very first sentence of this page says: "Finally, we display the histogram of the number of split counties over our generated redistrictings. We find a median of 21 split counties with a mean of 21.6 and a range from 14 to 31."
A Correct.
Q The way I read that is a range means 14 was the fewest number of county splits. Am I reading that correctly?
A I apologize. Earlier you had said 14 and maybe you misspoke or I misheard, so I thought you were talking about 14.
Q So the fewest number of county splits in your generated redistrictings were 14?

A In this first set of generated redistrictings, not the second set, which is on Figure 17.
Q Okay. All right. But there was one set of generated redistrictings that you did where the fewest number of county splits was 14?
A That's correct.
Q And whether it's 14 or 13, you would agree with me that the number of generated redistrictings with 13 or 14 split counties is a tiny fraction of the overall number of generated redistrictings, isn't it?
A Well, if it was 4 percent, yeah, it's a small fraction, but there are 14,000, almost 15,000 redistrictings.
Q Now, in looking at the Adopted Criteria, Exhibit 1007, you mentioned -- I think you were saying this in the context of validation work that you did. You looked at the candidacy versus incumbency. Could you explain that again, what you were looking at? You were using other election results to validate some work?
A Right. So we also looked at a set of other elections and reran the box plot to see what the general structure was, and the point was that those didn't have the same incumbency or the same candidacy structure as the 2016 or 2012 races. So the fact that in all cases we got qualitatively the same structure, a general slope in the box plot and this S-shaped curve for the two General Assembly Plans, thereby controls for that factor.

Q Okay. So you did look at incumbency to that extent, but you chose not to look at an incumbency by creating a threshold that would ensure no incumbents were paired?
A It's a different criteria, but no, we didn't.
Q And in terms of incumbency and trying to be consistent with what the legislature did, did you build anything into your algorithm that would evaluate how much of the core of each district was retained from the old plan to the new plan?
A No, we did not. We preserved counties.
Q Okay. So to the extent that you looked at the retention cores of districts, you were looking at counties but not the core itself?
A I'm not quite sure what you mean by "core," but no, we did not do anything like that.

MR. STRACH: That's all I have, Your Honor.

JUDGE OSTEEN: Anything?

MR. EPSTEIN: Nothing further, Your Honor.

JUDGE WYNN: Let me just make it clear, Mr. Strach. In regard to the advisability in terms of taking -- whether we will consider these exhibits, we surely will consider them. I want to look at the record more carefully to determine, at least in terms of expert disclosure, to the extent the door was not opened by your questioning.

But as a matter of prudence, it would be prudent for you to question him regarding those exhibits. If you need to

have the opportunity to recall him later in this week upon your further study of it, I, for one, would be in favor of it, and I think my colleagues would be okay with that.

MR. STRACH: Your Honor, I appreciate that. I will note that this question was asked at his deposition, so it's not as if this was the first time this ever came up.

JUDGE OSTEEN: Do you want to reserve the right to recall him later? I'm not saying you have to, but Judge Wynn -- we want to make sure we get this right.

MR. STRACH: I appreciate that. I certainly won't turn that down, but I would ask that if we decide not to recall him that that not be held against us on our request for --

JUDGE WYNN: Oh, no. This is just to make sure that you're afforded every opportunity to cross-examine on those reports. You -- by your questions, you had a report in front of you in which the doctor based his conclusions about his own study. You then said, Wouldn't this be different essentially if you had considered further studies?

He said, Yes, I've looked at others. And we left it there.

Then on redirect, he then comes up and says, Here, yeah, I looked at it. And then the exhibits come forth.

Typically an expert disclosure, you're correct, you have to bring those forward; but in the manner it's being presented here, there's a serious issue here as to whether we

should not consider this out of fairness. This is a bench trial, first of all, and I just want to be clear on that. I don't want you to be blindsided if you -- if there's something there that you want to challenge, I want you to have every opportunity to challenge it.

MR. STRACH: And we certainly appreciate that. Normally, of course, we would have had a chance to test this through depositions, et cetera, but we'll certainly do the best we can. We appreciate it.

JUDGE OSTEEN: Now is the time to take a look at it.

You may step down.

MR. THORPE: At this time, Your Honor, Plaintiffs would call Jowei Chen.

JUDGE OSTEEN: Just to help keep the record straight -- I don't know who is going to be standing up to conduct the examination, so when you stand to do an examination, if you would state your name.

Mr. Strach, in fairness to the Plaintiffs, I'm making them use the podium during their direct examination and so you need to be on a level playing field, unless we change things. So the cross-examination needs to be conducted from the podium, too.

MR. STRACH: Okay. Thank you.

MR. THORPE: Your Honor, Ben Thorpe from Bondurant Mixson & Elmore on behalf of the Common Cause Plaintiffs.

JUDGE OSTEEN: All right.

(Witness sworn by the clerk.)

MR. THORPE: Your Honor, may I approach the witness with the notebook as these are handed out?

JUDGE OSTEEN: You may.

JOWEI CHEN,

PLAINTIFFS' WITNESS, SWORN AT 2:22 p.m.

DIRECT EXAMINATION

BY MR. THORPE:

Q Would you state your name for the record, please?

A Jowei Chen.

Q And, Dr. Chen, what is your educational background?

A I have a bachelor's degree in ethics, politics, and economics from Yale University in 2004. I have a master's in science in statistics from Stanford University in 2007 and I have a Ph.D. in political science, also from Stanford University, in 2009.

Q And how are you currently employed?

A I am an associate professor at the University of Michigan in Ann Arbor in the Department of Political Science.

Q And have you been at Michigan throughout your academic career?

A Yes, sir, I have.

Q And do you have any other academic positions or appointments at this time?

A Yes, sir, I do. I am a research associate professor at the Center for Political Studies at the University of Michigan. I'm also a research associate at the Stanford Spacial Laboratory at Stanford University, and I'm a research associate, principal investigator at the Center for Governance and Public Policy at Willamette University in Oregon.
Q And in your academic work, what is your area of speciality within the field of political science?
A My areas of academic specialty are redistricting, political geography, and congressional legislative elections.
Q And how would you define political geography as you just used it?
A As I study it, political geography in my area of academic specialty is the study of things such as voters -- the political geography of voters, meaning where voters reside, and what implications that voter geography has on issues such as and relating to legislative districting.
Q Dr. Chen, you have in the first tab of your binder Joint Plaintiff's Exhibit 2012. That should also appear on the screen.

You have the exhibits we're going to reference in front of you. To make sure everyone is on the same page, they will also display on the screens.

Can you identify this exhibit as a copy of your CV?
A Yes, sir, it is.

Q And does that CV accurately represent your academic background and history and employment?
A Yes, sir, it does.
Q And does that CV list all publications that you have authored in the last ten years?
A Yes, sir, it does, except for the last few publications, which on this particular CV were listed as forthcoming articles. They have since been officially published and are in print.
Q So that includes the two forthcoming articles listed on the second page of your CV?
A Yes, sir, that's correct.
Q And the last of those articles is entitled "Analysis of Computer-Simulated Districting Maps for the Wisconsin State Assembly." That article has since been published?
A Yes, sir, it has.
Q And it's published in a peer-review journal?
A Yes, sir, in *Election Law Journal*.
Q You have previously presented expert reports in other litigation, is that correct?
A Yes, sir, I have.
Q And you have previously testified at trial?
A Yes, sir, I have.
Q As an expert witness?
A Yes, sir.

Q At what trials have you testified?
A Well, I have a full list of other cases in which I have done work on the first page of my expert report in this case, but the specific cases in which I've testified at trial are the 2015 Raleigh Wake Citizens Association versus Wake County Board of Elections and then in 2017 City of Greensboro versus Guilford County Board of Elections, sir.
Q And just for the record, the first page of your expert report is the first page of Joint Plaintiffs' Exhibit 2010, is that correct?
A Yes, sir, that's correct.
Q You have also submitted expert reports in additional cases?
A Yes, sir, I have and I've listed those on the first page of my report in that second paragraph.
Q And in each of these cases where you were asked to testify at trial, were you admitted as an expert?
A Yes, sir, I was.
MR. THORPE: At this time the Common Cause Plaintiffs tender Dr. Chen as an expert in political geography and redistricting.
JUDGE OSTEEN: And redistricting, is that what you said?
MR. THORPE: Yes, Your Honor.
JUDGE OSTEEN: Any voir dire or any objections?

MR. STRACH: Not on that, Your Honor.

JUDGE OSTEEN: All right. Dr. Chen is accepted as an expert witness in political geography and redistricting and may offer his opinion as to those matters.

MR. THORPE: Thank you, Your Honor.

BY MR. THORPE:

Q Now, Dr. Chen, just to be very clear about what your task was in the expert testimony that you're going to give here, what have the Common Cause Plaintiffs asked you to evaluate in this case?

A The Common Cause Plaintiffs asked me to evaluate two questions. First, I was asked to evaluate whether partisan considerations were the predominant factor in the drawing of the Enacted 2016 SB2 Plan; and second, the Common Cause Plaintiffs asked me to evaluate the extent to which that SB2 Plan, the 2016 Plan, complied with the nonpartisan portions of the Adopted Criteria as outlined by the Joint Select Committee.

Q And the research question isolated in this report is described at the bottom of page 1 and the top of page 2 of your report, is that correct?

A That's correct, sir.

Q As an overview -- and, of course, we're going to dive into greater detail on this -- how did you go about answering these two questions that you were asked?

A I went about answering these two questions by developing

and analyzing a computer-simulation algorithm which I've developed in my own academic research -- my published academic research that produces a large number of districting plans -- alternative districting plans produced by computer algorithm and this algorithm follows specific nonpartisan criteria that I programmed into the algorithm.

So I conduct a large number of simulations of simulated plans, independent simulations; and I analyze these simulated plans; and I compare them to the Enacted SB2 Plan along a number of measures, including, of course, the nonpartisan portions of the Adopted Criteria, as well as partisan measures.

Q And broadly -- again, we will deal with this in more detail -- what did you find as a result of conducting these simulations and evaluating them as against the enacted plan?

A Broadly what I found was that the partisan goal laid out in the Adopted Criteria, specifically the goal of creating a districting map with ten Republican seats, I found that that partisan goal predominated in the drawing of the SB2 Plan; and I found that the pursuit of that partisan goal, that partisan goal of creating a ten Republican map, not only predominated the drawing of the map, but it subordinated the nonpartisan portions of the Adopted Criteria. Specifically, I found that it subordinated the portions of the Adopted Criteria relating to avoiding the splitting of the counties, keeping counties

whole when possible, as well as the geographic compactness of districts.

Q And for your conclusion that partisanship predominated in the drawing of those districts, what is the basis of that conclusion as a mathematical matter?

A Sure. The basis for that conclusion, as I started explaining earlier, was I analyzed a large number of districting maps. So what I found was the SB2 Plan, the Enacted 2016 Congressional Plan, created a partisan outcome, created a partisan distribution of seats that is an extreme statistical outlier in terms of its partisanship, in terms of its creation of ten Republican seats; and that the SB2 Plan in creating this extreme 10-3 Republican outcome was creating an outcome that was entirely outside of the range of the sorts of plans that would have emerged under a districting process that adheres strictly to the nonpartisan portions of the Adopted Criteria.

Q To understand how you reached that conclusion, I want to take a step back. When you refer to computer-simulation techniques or to data algorithms, specifically what is it that you are describing?

A I'm describing computer-simulation algorithms that I have developed in my own academic research in which I am able to program a districting process designed to follow certain criteria that I program and ignore criteria that I want the

program -- the computer to ignore.

So in this particular case, I programmed in or I had the computer strictly follow the nonpartisan portions of the Adopted Criteria. In following the Adopted Criteria, I had the simulation process or the districting process ignore, for example, race altogether. I also instructed the computer to ignore partisan considerations altogether.

Q And we'll talk about the criteria that go into those maps, but does the algorithm also generate all the data necessary to visually display an actual map created by that process?

A Yes, sir, it does. It creates actual maps, ones that you can compare to a map, an image, of the SB2 Enacted Plan or any other Congressional Plan that one might want to consider. So it creates actual districting maps for North Carolina, dividing North Carolina into 13 congressional districts.

Q And is Figure 1 in your report, which appears on page 8 of your report, an example of such a map?

A Yes, sir, it is. It is an example of a simulated map.

MR. THORPE: Okay. For the Court's benefit, we would like to introduce as an illustrative exhibit Plaintiffs' Exhibit 3041, which will allow Dr. Chen to explain how the simulation process actually yields something like Figure 1. We would move for admission of that exhibit.

JUDGE OSTEEN: Okay. So the PowerPoint is exhibit what?

MR. THORPE: 3041.
JUDGE OSTEEN: 3041.
MR. THORPE: I'm sorry.
PARALEGAL IN GALLERY: The PowerPoint from Dr. Mattingly was 3040. This is 3041.
THE COURT: So we've got the exhibit in the book at page 8 that we're looking at now. Then there's a PowerPoint exhibit that is -- what's 3040?
PARALEGAL IN GALLERY: That's the PowerPoint. That's the actual one that was used with Dr. Mattingly.
JUDGE OSTEEN: Okay. 3041?
MR. THORPE: I said this is 3041.
JUDGE OSTEEN: Any objection to that?
MR. STRACH: I haven't seen it yet. Let me take a look at it.
(Pause in the proceedings.)
MR. STRACH: No objection.
JUDGE OSTEEN: All right. Then I guess it's Exhibits 3040 and 3041 are admitted.
MR. THORPE: My understanding, Your Honor, is that Exhibit 3040 was the PowerPoint for Dr. Mattingly.
JUDGE OSTEEN: Oh, the earlier PowerPoint.
MR. THORPE: Yes, sir.
JUDGE OSTEEN: So this is 3041.
MR. THORPE: Yes. And what's on the paper here will

also be displayed.

JUDGE OSTEEN: Multiple pages?

MR. THORPE: Yes.

JUDGE OSTEEN: Exhibit 3041 is admitted.

BY MR. THORPE:

Q So, Dr. Chen, explain what we're looking at on the first page of Exhibit 3041.

A This is just a map of North Carolina's VTDs, voting tabulation districts, as well as county boundaries. So I'll just call them VTDs or they're sometimes called precincts. This is all the VTDs in North Carolina.

The simulation algorithm starts with VTDs because this is the basis for districting as laid out by the Adopted Criteria. The Adopted Criteria tell us that VTDs in general cannot be split unless you actually need to do so for reasons of equal population, but in general, you have to start with VTDs, and so that's why I began with North Carolina's VTD boundaries in starting the drawing of any districting map by my computer.

JUDGE WYNN: Counsel, is that what this is supposed to be showing? This looks like a county map to me.

MR. THORPE: Yes, Your Honor, it is a county map which contains lighter shaded VTD breaks in between.

JUDGE WYNN: We have very old eyes here and I think to be able to see those districts you have really got to pierce

through this.

MR. THORPE: Hopefully, it will be more visible on the screen when it begins to be colored in.

JUDGE WYNN: This is worthless. This is nothing but a county map here from what I'm looking at here. I mean, if you're going to do these things, you ought to be careful and at least make sure that it represents what it is. There was one previously up that actually had it in there, had all of them, looked much like it, but this -- I'll accept that's what it's supposed to show, but I'm just telling you that's not what this is.

MR. THORPE: Yes, Your Honor. And I apologize for any lack of clarity on that. Hopefully, as we discuss any county line splits within this, the VTDs boundaries will become clear. But I apologize.

BY MR. THORPE:

Q How do your maps start being created based on the instructions you give the computer?

A The computer starts just by picking a random point on the map, somewhere in North Carolina, and that is how the construction of the first district in this plan begins. So it picks a random point and it begins building outward and, as I said, it uses VTDs as the basis for building these districts. So it constructs the first district by adding together adjacent VTDs until you construct an entire first district.

Now, when you do so, there are, of course, other portions of the Adopted Criteria that are followed here. Most importantly, splitting of counties is to be minimized. Counties are to be kept whole as much as possible. So that means that when the computer adds an adjacent VTD, it tries to pick a VTD from within a county it has already intruded into before moving into new counties. That is how any districting process is going to minimize the splitting of counties or trying to keep counties whole as much as possible.

Q But at some point, in order to complete the district, some county split is created, is that correct?

A That is correct. The Adopted Criteria tell us that districts have to be perfectly equally populated, which for North Carolina means 733,498 or 99 in population for every district, and it has to be exactly that number. So this means that when you get to the very end of completing one district you are inevitably going to end up in the middle of a county without necessarily filling out that entire county. That's how county splits are created. The Adopted Criteria tells us that counties can be split in order to equalize population.

So inevitably, at the end of the first district, you're going to have to split one county, but you don't have to split any more than that. You also need to split one VTD in order to get precisely to that number 733,498, but you don't want to split any more VTDs than that just to create equal

population. That's how the first district is created.
Q After that first district is created, how does the second district get created?
A The second district gets created by starting right where the first district left off. So it begins by picking up that county that was left unfinished by that first district, fills that one out, and again proceeds exactly like the first district does. It keeps on adding adjacent VTDs following those same rules before. You add VTDs that are within counties you've already entered into and don't move into a new county until you've completely filled out that first county. So it keeps on doing that until, once again, you get to exactly 733,498.

And, of course, at the end of that second district you're going to need, inevitably, to split apart one more county and exactly one more VTD, but you don't split those apart for any reason other than the Adopted Criteria lays out splitting up the VTD simply for the reason of population equality. So that second district is created much the same way and the same goes for all subsequent 13 districts.
Q And we can advance to -- so that shows an example which appears in Figure 1 of your report of one of the simulations that you generated for the purposes of this report, is that correct?
A Yes, sir.

Q And, again, we'll talk about this in more detail, but how many total simulations did you create?
A Well, I created a total of 3,000. I did three sets of simulations using slightly different algorithms, slightly different rules; but for each set of simulations, I conducted 1,000 simulations, so 1,000 separate maps. And this is just one example among those 1,000 or among those 3,000 total maps, but every map is completely different. It starts in a different way, but it follows that same basic algorithm that I just outlined.
Q And so particular geographic features of this map may not be matched in any other map or in some uncertain number of other maps, is that correct?
A That's correct, sir. All the maps are different.
Q Including which counties are split as a result of the random starting point of the map?
A That's correct, sir. The different maps split different counties, different combinations of counties.
Q So this varies slightly from Figure 1 in that Figure 1 also displays a variety of information about the resulting districts, is that correct?
A That's correct, sir. So once I complete or once the computer has completed the construction of the entire 13-district map, my computer then goes back and calculates various statistics relating to the Adopted Criteria describing

the districts on the map.

So, for example, obviously I've calculated the population here in the left column, the population of all the 13 districts; and it just shows that these districts are, in fact, equally populated, that everybody has 733,498 or 99 in population. So you can calculate certainly the population, but I also calculate measures relating to geographic compactness. I also calculate measures relating to how many counties were split and how many VTDs were split.

So in this map, we see that I have displayed the various geographic compactness measures along the measures of Reock and Popper-Polsby, and these are just very commonly used measures of geographic compactness where higher scores denote greater geographic compactness. So I've calculated the compactness scores of all the districts here; and, of course, you can calculate the average score, the average Reock and the average Popper-Polsby, among all 13 districts.

Then I've also calculated which counties were split and which VTDs were split, and we can see here in this map there were exactly 12 counties split and exactly 12 VTDs split, which is a result of the districting algorithm minimizing or avoiding when possible the splitting of VTDs and counties, except to equalize population.

Q And your simulation approach and the data that you have produced in connection with it reveals all of this data about

any one of your 3,000 simulated maps, is that correct?
A That is correct, sir. I turned over electronic maps of all 3,000 of the simulated maps, so 3,000 completely different districting maps.
Q And just to be clear, when you say turned over those maps it creates actually a shapefile of the map, as opposed to something identical to Figure 1, is that correct?
A Exactly, sir. A shapefile is how we store maps electronically on computers.
Q But this data is available as a result of the various folders that capture all of the simulations that you did?
A That's exactly right, sir. So in addition to those shapefiles, I also turned over data files listing out these various characteristics, as we see here, of every single one of those 3,000 maps.
Q Just to be clear, because the numbers don't necessarily conform to what we've come to expect of actual North Carolina districts, do the numbers that you assign to given districts mean anything in correspondence to our current District 1 or District 13?
A No. I made no attempt to assign any sort of meaning to which district gets numbered as number one. I found that to be not really part of my task because the Adopted Criteria don't tell us anything about the numbering system that is to be used. I number them simply for the sake of organizing the files, but

the numbers mean absolutely nothing substantively.
Q And also just for clarity, Figure 1 represents a single simulation from your third set of simulations that we will discuss, is that correct?
A It represents an example from the second set of simulations --
Q Oh.
A -- that I produced.
Q And so the additional information that we know about this map appearing in Figure 1 is that all of the 13 incumbents will be placed in separate districts, is that correct?
A Yes, that is one thing I found about this map. I would just add that among those files that I turned over were files that identified which incumbents were in which district in every one of those 3,000 maps. So the files that I turned over did, in fact, identify the incumbency information listed here in this map.
Q Understood. I want to move to discussing the various criteria that you used to create this map.
MR. THORPE: And, Stacy, I think we're done with that simulation or demonstration.
BY MR. THORPE:
Q You stated that you created 3,000 maps?
A Yes, sir.
Q And the first set of maps that you created, you created

1,000 maps, is that correct?
A Yes, sir, that's correct.
Q What criteria did you use to conduct that initial set of simulations?
A So I'll explain the criteria and, broadly, these are criteria taken from the nonpartisan portions of the Adopted Criteria. What I broadly wanted to do was to hold several redistricting factors constant so that I could evaluate whether or not the as-enacted SB2 map conformed to these or could be explained simply in terms of it being a partisan-motivated map. So the specific criteria that I followed here in Simulation Set No. 1 were taken directly from the Adopted Criteria.
Q And when you say "the Adopted Criteria," Dr. Chen, you are referring to Exhibit 1007, which should appear at the third tab of your binder?
A Yes, sir, that's correct, the 2016 Joint Select Committee Adopted Criteria.
Q And you have referred to these earlier today as the nonpartisan criteria from the Adopted Criteria. What do you mean by that?
A What I mean by that, sir, is that this Joint Select Committee Adopted Criteria document contains both partisan, as well as nonpartisan, factors.
Now, I explained my goal in this expert report; and it was to -- in part, to evaluate the extent to which the

Enacted SB2 Plan conforms, adheres to the nonpartisan portion of the Adopted Criteria. So in evaluating that, I, of course, had to ignore the partisan mandates of the Adopted Criteria specifically relating to its mandate of the creation of a ten Republican, three Democrat congressional map. So I certainly ignored that portion.

As well in Simulation Set No. 1, I ignored the Adopted Criteria's mandate of protecting incumbents; and the reason I ignored that part is that even though it's not an explicitly partisan criteria, given that the 13 incumbents as of November 2016 are coming from an existing -- the previous congressional map, there's certainly the possibility that there is some indirect partisan effect if we were to draw districts explicitly to protect those existing incumbents as of November 2016 given that they arose from the plan drawn for the 2012 and 2014 congressional elections.

So those were the portions of the Adopted Criteria I ignored in Simulation Set No. 1.

Q Dr. Chen, I'll direct you to page 6 and the top of page 7 of your report where you list criteria that the computer algorithm followed. Are these the criteria that you're referring to when you say the nonpartisan portion of the Adopted Criteria that you used to simulate Set One?

A Yes, sir. So I've listed out here on page 6 the five nonpartisan criteria that I factored, that I built into

Simulation Set No. 1. Specifically, the Adopted Criteria tell us, obviously, that districts have to be perfectly equally populated; second, that obviously districts have to be geographically contiguous. Those are fairly standard and not very different than for, say, other states, but the Adopted Criteria also give us very specific nonpartisan instructions with respect to No. 3, avoiding county splits.

And so the Adopted Criteria specifically tell us that, number one, if you do split a county, you cannot split it into more than two districts. You cannot split, say, Mecklenburg County or any other county into three districts or four districts. You can only split it, at most, into two districts. More importantly, the Adopted Criteria also tell us that you should avoid splitting counties when possible, that they are to be minimized, and that you can split counties when you need to do so to create equally populated districts. So that's a third criterion.

Q And where does that criterion appear within the Adopted Criteria because you just outlined several things? I want to be able to point where in the Adopted Criteria that shows up.

A Yes, sir, in the Adopted Criteria, it's the paragraph that's labeled "Compactness."

Q Understood. In addition, your simulation algorithm introduces or, rather, measures compactness by other measures that you previously referenced with Figure 1, correct?

A Yes, sir, that's correct.
Q And what are those measures?
A Sure. I just wanted to mention before I got to compactness, though, that the fourth criterion is minimizing VTD splits and the Adopted Criteria there tells us that you can only split VTDs when necessary to create equal populations, as I mentioned earlier in describing my algorithm.

And then the final one, in response to your question, sir, is about geographic compactness. So the algorithm prioritizes the drawing of geographically compact districts, and I measure that and operationalize that using two standard measures of geographic compactness that scholars of redistricting -- of legislative redistricting use very commonly in the scholarly literature, as well as in court case work. Those two measures are Reock and Popper-Polsby.
Q And those measures are described on pages 6 and 7 of your report, is that correct?
A Yes, sir, that's correct.
Q Returning to the first criterion that you referenced, I just want to be very clear about the instruction that you gave the computer in creating these simulated maps. Did you instruct the computer to conduct simulations that created districts with zero population deviation?
A That is correct, sir, I did and I found that that was very straightforward to do and so all of the districts in all of the

3,000 maps that I produced for this report all have a population deviation of -- sorry -- a population in the district of either 733,498 or 99.

I mean, specifically the way that North Carolina's statewide population breaks down if you divide it across 13 districts is you need exactly four districts with 498 and then the remaining nine districts that have 499. So you're going to have four districts with 733,498 and the remaining are going to be 99. That's just how North Carolina's population breaks down and that is strictly adhered to in every one of my simulated -- 3,000 simulated plans.

Q And so as a result of how you designed that algorithm, it was not necessary on the back end of the simulations to zero out the population to meet this criteria?

A No, sir, I did not go through by hand and do any manual fidgeting with the district boundaries or the assignment of census blocks or anything like that. It was entirely automated by the computer districting process.

Q You have previously conducted other simulations of congressional and legislative redistricting, correct?

A Yes, sir, that's correct.

Q And in those previous either expert engagements or in your academic work, have you always been given a written set of criteria to follow?

A No, sir. This is quite rare.

Q And what does that affect about your approach to the task in this case?
A Well, it meant my task in this particular case was unusually narrow and very mechanical, meaning the following: The Adopted Criteria here in this case give me a very specific set of criteria and my task was to not deviate from the nonpartisan portions of that Adopted Criteria. They were obviously very specific with respect to things like population equality and contiguity, but also county splits, which was quite unusual.

Usually my task in -- either as an expert witness or in my academic research is to make subjective judgments or use my expert as a redistricting expert and make determinations about how traditional districting criteria should apply in this state or that state or this jurisdiction and then try and figure out how to apply them -- how to apply traditional districting criteria given the various quirks of a particular state.

In North Carolina, in this particular case, with the Adopted Criteria as specifically as it is written, I had no subjective judgments like that to make here. My task here was very mechanical, to very strictly follow the words that I saw on the paper of the Adopted Criteria and to follow those rules by programming them into the computer algorithm. They were even very specific with respect to the hierarchy of these

various criteria.

So that's what made this case so unusual in terms of my own normal academic work and expert witness work using redistricting simulations. Here I had no -- very little judgment call in deciding what districting criteria should be in or which ones should apply here. It was all very clearly laid out for me in the Adopted Criteria.

Q Do the adopt criteria also specify which election and/or demographic data is to be used in the construction of these maps or these districts?

A Yes, sir, it does.

Q And where is that specified?

A Well, the Adopted Criteria tells us which elections are to be used. I believe it's the section called "Political Data." But the Adopted Criteria tells us which elections to use in the consideration of the partisanship of the districts in achieving the stated political impact or partisan goal of the Adopted Criteria.

So specifically that "Political Data" paragraph in the 2016 Adopted Criteria tell us that the data we are to use are the following: All the statewide elections from 2000 -- from 2008 to 2014, but not including the presidential contests. So that is a very specific list of exactly 20 statewide elections.

Q And what you just said you have read from the first

sentence under "Political Data" on page 1 of the Adopted Criteria itself?
A That is correct, page 1, the section called "Political Data," and it tells us which elections to use.
Q And does that section also describe any demographic data that may be used in the construction of districts?
A It tells us to avoid using certain demographic data. It tells us to avoid using the racial composition of any of the census geographies or of any data about North Carolina. So that's pretty easy to follow. I just ignore racial data because the Adopted Criteria tell me to ignore racial data.
Q And so specifically it reads: "Data identifying the race of individuals of voters shall not be used in the construction or consideration of districts in the 2016 contingent congressional plan."
Did you follow that in your construction and consideration of the simulated districts in order to follow the nonpolitical portions of the Adopted Criteria?
A Yes, sir. I considered that to be one of the various nonpartisan portions of the Adopted Criteria. So that sentence tells me that racial data, data identifying the race of voters, is not to be used; and so I followed that by completely ignoring all racial data in constructing my computer's districting simulation algorithm.
Q And when I speak of whether you constructed districts

based on that result or considered that information, I am referring to the information contained in your expert report disclosed on March the 1st of 2017?

A Yes, sir, that's correct.

Q So the political data bullet point that you just referenced includes 20 elections. Was that the only election formula that you considered for the purposes of this task?

A It was one of two different formulas that I used. There was a second one as well.

Q What is the other formula? And I will direct your attention to the next tab, which is Joint Plaintiffs' Exhibit 2002.

A This document is a document that Plaintiffs' counsel gave to me and represented to me that it was the formula produced by Dr. Tom Hofeller used for evaluating partisanship of North Carolina congressional districts while he was producing the 2016 Plan. Plaintiffs' counsel gave me this document, told me it was produced by Dr. Hofeller in evaluating the partisanship of North Carolina's congressional districts.

I looked at this formula and I found seven elections and I found it was a very straightforward formula to apply. I saw seven elections and they're really just a subset of those 20 statewide elections I mentioned just a second ago that were mentioned in the Adopted Criteria.

So Dr. Hofeller's formula lists for me seven

elections and it creates a very specific formula used to evaluate the partisanship of districts. I looked at it and I saw that I had access to all of this data, all seven of these elections, and I found it to be pretty reasonable and straightforward to apply, and so I applied it as well.

Q And you've mentioned applying this formula at the district level. Is it your understanding that this formula could only work at the district level?

A No. I understand it to be a formula that was constructed by Dr. Hofeller for the consideration, for the evaluation of the partisanship of any geography. It could be the partisanship of a county or the entire state of North Carolina, of a region in North Carolina. It's just a formula that takes a couple of different elections, puts them together, aggregates the results; and all it simply does is it counts up were there more Republican votes or Democratic votes in this particular district across the seven elections. So it's a very straightforward formula that can be applied to any sort of geography within North Carolina obviously.

Q And this formula could easily be applied at the VTD level as well?

A Yes, sir. I mean, it's all data that's available at the VTD level and it's pretty clear what Dr. Hofeller was creating here.

Q Understanding that these elections were provided to you as

you've just testified, do you have an opinion about the reasonability of using either the 20 elections or Dr. Hofeller's formula to assess the underlying partisanship of an individual geographic unit in North Carolina?

A I do. In general, I just accepted that this was Dr. Hofeller's understanding of the partisanship or at least Dr. Hofeller's conception of the partisanship of North Carolina's congressional districts. But obviously, I'm a political scientist who studies election results and so I looked at this formula and I looked at the various elections used in this formula and it strikes me as a reasonable formula. It may not be a perfect formula, but it strikes me as a fairly reasonable way to measure across several election cycles and across several different races the general partisanship of North Carolina voters in any given district.

Q And principally you accepted that either the 20 elections or the 7 elections referenced in the document we were just discussing were, in fact, used for that purpose in the creation of the 2016 Plan?

A Yes, sir, I accepted Plaintiffs' counsel's representation of that fact, that these were the formulas that represented how Dr. Hofeller measured or understood or perceived the partisanship of North Carolina congressional districts, and I accepted that Plaintiffs' counsel told me that the Adopted Criteria was an accurate representation of the legislature's

instructions or intent in drawing the map.
Q And then used those instructions that you understood to be explicit to create your own set of simulations?
A Well, yeah, that's correct. So I created my own simulations, as I said, in the past using the nonpartisan portions of the Adopted Criteria, but then I went back and evaluated the partisanship of every one of those districts in every one of those 3,000 maps using both Dr. Hofeller's formula and then later on using the 20-election formula as laid out in the Adopted Criteria.
Q Before we dive in more specifically to the results for Simulation Set One, it also appears that you conducted two additional sets of simulations after the first run of a thousand. Why did you do that?
A I conducted the two additional set of simulations in order to assess the plausibility of alternative explanations for why the legislature might have drawn or needed to draw the SB2 Plan with ten Republican seats.

So specifically, I conducted the second set of simulations to evaluate the possibility that the legislature's stated desire in the Adopted Criteria to protect incumbents each in his or her own district might somehow account, explain or necessitate the creation of a 10-3 Republican map.

And then I created a third set of simulations, Simulation Set No. 3, to consider the altogether different

possibility that perhaps there were something specific, perhaps something specific in the unique combination of features of the Enacted SB2 Plan in terms of its unique combination of the 13 county split and exactly 11 protected incumbents that might somehow explain its creation of an extreme 10-3 Republican map.

So I did these additional sets of simulations as robustness checks to evaluate those possible alternative explanations for why the enacted plan, the SB2 Plan, was such an extreme partisan outlier.

Q And so with respect to Simulation Set One, you tested the criteria in -- the Adopted Criteria that you determined for that set you would consider nonpartisan criteria, is that correct?

A Yes, sir, I considered just the nonpartisan portions of the Adopted Criteria in Set One.

Q So you did not consider partisan advantage?

A That is correct. In Simulation Set No. 1, I solely stuck to nonpartisan criteria, did not consider political incumbency, and did not consider partisan advantage in the construction of these simulated plans.

Q Including in determining whether and when to split counties?

A That's correct, sir. Those were all applied in nonpartisan fashions.

Q I'm going to direct your attention to page 13 of your

report, which is Figure 2. What does Figure 2 show, Dr. Chen?
A Figure 2 describes the partisan results, the results in terms of partisanship of this first set of simulations that I just finished describing. So once again, this is the set of simulations in which the computer is strictly following the nonpartisan portions of the Adopted Criteria. It is paying no attention to any sort of political data, as well as anything about any incumbents; and that's before, of course, it's completely ignoring racial data.

So this figure on the left of Figure 2, this histogram, this is a diagram that tells us about the number of Republican districts in all of these 1,000 simulated plans in Simulation Set No. 1. It's also telling us about the partisanship, the number of Republican districts, of the Enacted SB2 Plan.
Q So explain what you mean by the two descriptions on the X and Y axis of this histogram.
A What I'm plotting here on the horizontal axis along the bottom of this figure is the number of districts that have over Republican -- 50 percent Republican vote share. In other words, how many Republican districts were there as measured using Dr. Hofeller's formula, that formula that we just looked at a few minutes back.

So I applied Dr. Hofeller's formula to every one of the 13 districts in every one of these 1,000 simulated plans.

For each one of these computer-simulated plans, I simply counted up how many -- out of 13 districts how many of those 13 districts are Republican rather than Democrat in terms of using and applying Dr. Hofeller's formula. Dr. Hofeller's formula was a very straightforward way using those seven elections to tell us whether a district was Republican or Democrat; and so I used that, applied that across the 13 districts, and counted up how many of those 13 districts are Republican districts rather than Democrat districts.

Q And the frequency with which your simulations generated a particular number of districts with more Republican votes based on that formula is captured by the vertical axis?

A Correct, is captured vertically. So this is a chart that's just telling us how many of those 1,000 simulated plans -- and remember that these are 1,000 completely independent, completely different districting plans for North Carolina's congressional districts. So there are 1,000 different plans here; and I'm counting up how many created exactly five Republican seats, how many created exactly six Republican seats, how many created exactly seven Republican seats, and so on.

Q And among the range of possible outcomes you observed in this analysis, what was the most frequent result?

A The most frequent outcome was plans that created exactly seven Republican seats. In other words, seven Republican and

six Democratic seats, that was an outcome that occurred a little bit over 45 percent of the time. So almost half the time it was exactly 7 out of 13 Republican seats.

Q And what was the second most likely outcome?

A Second most likely outcome is six Republican seats. So we see that's happening 32 percent of the time, so approximately 320 out of those 1,000 simulated plans. Put together -- another way of seeing that is to say that the vast majority of these plans are either six or seven Republican seats, meaning that they have six Republican and seven Democratic seats or seven Republican and six Democratic seats. That's what's happening in these simulated plans most of the time, the vast majority of the time here.

Q And how frequently did this set of 1,000 simulations yield ten Republican and three Democratic seats?

A It never did so. Zero out of 1,000 times. It never created ten Republican and three Democratic seats.

Q And is that captured in the red text showing where the SB2 Enacted Plan winds up on this chart?

A Yes, sir, that's right. So you see a red bar there -- a red dotted line and I've plotted out there SB2 Enacted Plan. That represents the SB2 Enacted Plan's creation -- using Dr. Hofeller's formula, the creation of ten Republican seats as measured using Dr. Hofeller's formula. So that red line is telling us that the SB2 Enacted Plan created ten Republican

seats. And once again, we can look at the entire distribution of those 1,000 computer-simulated plans. We can see that that range is between five to nine and most of the time, as we just mentioned earlier, it is usually six or seven.

So what that tells us is that the SB2 Enacted Plan's creation of ten Republican seats is an extreme statistical outlier. It's creating ten Republican seats and that is an outcome that is entirely outside of the range of plans created under Simulation Set No. 1 following the nonpartisan portions of the Adopted Criteria. So it's entirely outside of this range of simulated plans.

Q And you performed the same analysis using the 20 elections specified in the Adopted Criteria as well, correct?

A Yes, sir, a completely separate formula that we just described -- that I just went over a while ago of taking those 20 elections that were mentioned in the "Political Data" portion of the Adopted Criteria, and I applied that formula with those 20 elections. Those election results were all available to me and so I evaluated the same 1,000 plans a second time, except this time, instead of using Dr. Hofeller's formula, I used the Adopted Criteria formula.

And again, just to remind -- to go over what that was, the Adopted Criteria gave us 20 elections, and I simply counted up how many Republican votes and how many Democratic votes across those 20 elections there are in each district, and

that allows us to determine whether each district is a Republican or a Democratic district.

So once again, on the figure on the right I'm plotting out or I'm displaying the number of Republican seats in each of these 1,000 plans.

Q And just briefly, what do you find is the most likely result applying the Adopted Criteria elections to this simulation set?

A So right now we're looking at the figure on the right side here, Figure 2. That figure on the right side tells us that the most likely outcome -- and this is an outcome that occurs over half of the time again in these 1,000 simulated plans. That most likely outcome is six Republican seats. In other words, six Republican and seven Democratic seats.

So what this is telling us is that when you follow a simulation process that is strictly adhering to the nonpartisan portions of the Adopted Criteria over half the time you would create a plan that has exactly six Republican and seven Democratic seats using the Adopted Criteria elections, the formula laid out in the Adopted Criteria, for evaluating the political impact of North Carolina congressional districts.

Q Understood. And, again, just briefly, how likely is it that this simulation set using these elections would yield a ten Republican, three Democratic plan?

A Again, zero out of 1,000 times. Never.

Q How many times does it occur for nine Republican districts and four Democratic districts?
A Zero out of 1,000 times. It never occurs.
Q And how often does it occur in eight Republican districts and six Democratic districts?
A Less than 1 percent of the time. 0.5 percent of the time. So it very rarely occurs, 5 out of 1,000 times. For creating seven Republican districts, then it occurs a sizeable number of times, a small minority, at 13 percent.
Q And so based on this data that's before us in Figure 2, what can you conclude about the partisan distribution of seats in the SB2 Enacted Plan relative to the partisan distribution of seats among your simulated plans in Simulation Set One?
A Using either one of these partisan formulas, these partisan measures that I've just gone over, Dr. Hofeller's formula as well as the Adopted Criteria formula, using either one of those alone, I'm able to conclude with extremely high statistical certainty that the SB2 Enacted Plan's creation of ten Republican seats is an extreme outlier and it is entirely outside of the range of the sorts of plans that would emerge under my simulation process, under a districting process that strictly follows the nonpartisan portions of the Adopted Criteria.
Q You separately -- did you separately evaluate whether the plans in Simulation Set One tell us anything about the enacted

plan's compliance with other portions of the Adopted Criteria?
A Yes, sir, I did. I evaluated the geographic compactness, as well as the number of county splits, of the Enacted SB2 Plan as compared to all of the simulated plans.
Q And what did you find with respect to the compactness of those districts?
A Well, the compactness calculations, the compactness comparisons are shown on Figure 3.
Q And Figure 3 appears on page 14 of your report. I believe you are referring specifically to the left side of that page.
A Yes, sir, I'm referring just to the left side of this figure. This figure here on the left is a comparison of those 1,000 simulated plans that we've been talking about compared against the Enacted SB2 Plan along geographic compactness; and as I mentioned sometime ago, we're using two different measures of geographic compactness here, the Reock score, as well as the Popper-Polsby score. These are scores that generally tell you higher numbers mean greater geographic compactness.

So what this figure tells us is the geographic compactness along these two, Reock and Popper-Polsby, measures of every one of the 1,000 plans, as well as the Enacted SB2 Plan. It tells us that in the SB2 Plan we have, say, a Reock score of a little bit under .34. Now, that by itself doesn't mean anything without comparison to other plans. So that's what we have the simulated plans for. We're able to see what

is a reasonable geographic compactness score, what is a reasonable Reock score produced by a districting process that more strictly adheres to or tries to draw compact districts; and the answer is what we see in this figure here.

When you try and draw compact districts when you try and adhere to the Adopted Criteria's nonpartisan portions, you end up with plans that range in Reock from .38 -- from a little bit under .38 all the way up to about .48. That's the entire range. Now, where is the Enacted SB2 Plan? It's at .34. It's entirely outside of that range and very significantly far below that range, and what that tells me -- combined with the same thing when we look at the Popper-Polsby measure along the vertical axis, what that allows me to conclude is that the Enacted SB2 Plan was not the product of a reasonable effort to draw geographically compact districts because it was very straightforward, very easy, 1,000 out of 1,000 times, to draw a much more compact districting plan while otherwise maximizing adherence to the nonpartisan portions of the Adopted Criteria.

Q You just testified that the Reock score specifically of the enacted plan wouldn't necessarily be reasonable. Do you mean reasonable with respect to this entire population of simulations or reasonable as some absolute metric?

A I don't really read much into it as an absolute metric. For example, if you were to ask what is a reasonable Reock score if you were drawing congressional districts or state

legislative districts for the islands in the state of Hawaii, you would, of course, end up with much more geographically noncompact districts than if you were drawing a districting plan for the state of Wyoming, which it's much easier in the second example to be drawing compact districts. That's why I say that you have to put Reock scores in a context by comparing them to what could have been reasonably done. That's what the simulations -- the simulated plans allow us to do.

Q And so the data in Figure 3 provides that context via the simulations that you conducted?

A Yes, sir. It's telling us what sort of geographic compactness scores, what sort of Reock scores would emerge. Specifically in North Carolina and specifically trying to draw congressional districts specifically using 2010 census data, what sort of Reock scores would have emerged if you had tried to draw reasonable compact districts.

Q You said that you also evaluated county splits.

A Yes, sir, I did.

Q What did you find with respect to Simulation Set One relevant to the enacted plan?

A What I found is that in the first set of simulations -- and, again, this is the set of simulations that tries to maximize adherence to the nonpartisan portions of the Adopted Criteria, including the county split mandate, the mandate that you avoid splitting counties when feasible.

What I found is that it is very straightforward, again, 1,000 out of 1,000 times, to produce a congressional districting plan that splits only exactly 12 counties. You don't need to split any more than 12 counties. Counties are split when you need to equalize the population of districts in Simulation Set No. 1 and so it's very straightforward to create only 12 counties that are split into two districts.

Now, I also evaluated -- I also evaluated the Enacted SB2 Plan and I found that there were 13 county splits, so that allowed me to conclude that the SB2 Plan was not the product of a districting effort to minimize the number of county splits to only split counties only when necessary to equalize district populations.

Q I want to direct your attention back to the Adopted Criteria and specifically the compactness criterion that you earlier referenced. What is it in this compactness criterion that caused you to minimize the number of county splits in the creation of these districts?

A Right. Well, as we were discussing the simulation algorithm quite some time ago, the simulation algorithm pays great importance to the Adopted Criteria's mandate about keeping counties whole when possible.

And so the way it works is what the algorithm does is it doesn't go into a new county when building a district. It does not go into a new county until old counties, existing

counties inside of that district, have already been filled up by that district. So you don't intrude into a new county until you actually need to. That's how any districting process would minimize county splits. It builds those districts one by one and you don't go into new counties until you have to.

Q So there is a sentence in this criteria that reads: "Division of counties shall only be made for reasons of equalizing population, consideration of incumbency, and political impact." Is that correct?

A Yes, sir.

Q Would I be correct in describing Simulation Set One as following the rule that division of counties shall only be made for reasons of equalizing population?

A That's exactly what I did. I read that sentence and it lays out three reasons why one can divide counties: Equalizing population, but also to protect incumbents and political impact, which I read the Adopted Criteria to mean trying to create a ten Republican map or its political goal of creating a ten Republican map.

And as I said, in Simulation Set No. 1, I solely focused on the nonpartisan portions of the Adopted Criteria, so that -- when I read the sentence, that meant that division of counties can only be made in order to equalize the population of districts, not to create a 10-3 map or to protect incumbents here in Simulation Set No. 1. That's why I followed that rule

in Set No. 1, allowing counties to be split only when necessary to create perfectly equalized districts.

Q Understood. In Simulation Set No. 2, how did you vary that design?

A So in Simulation Set No. 2, I mostly followed the same algorithm, but I wanted to ask a slightly different question. I wanted to specifically ask whether or not the Adopted Criteria's mandate of protecting political incumbents -- of protecting the congressional incumbents might somehow explain or justify or somehow necessitate the creation of a map with as extreme of a partisan impact as the SB2 map.

Q So what did you do to test that proposition?

A What I did was I created a different algorithm, but it was exactly the same as the first algorithm in so far as it followed all of the nonpartisan portions of the Adopted Criteria and maximized compliance with the nonpartisan Adopted Criteria, but added one more feature. It explicitly intended to create districts that made sure that the entire districting plan as a whole protects all 13 incumbents specifically by avoiding the pairing of any incumbents. So it avoids putting two or more incumbents into the same district.

In other words, this is an algorithm that was exactly like Set No. 1, which we've been talking about up until now, except that it is mandating, it is requiring that every one of the 13 incumbents in North Carolina as of the November 2016

election is placed into his or her own district with no pairing or no double-bunking of incumbents.

Q Have you heard -- so you just referenced the double-bunking of incumbents. Do you understand that to mean placing more than one incumbent in a given district?

A Yes, sir, that's what I understand by that term.

Q And so is it correct that in Simulation Set Two all of your simulations obey the rule that no incumbents are doubled-bunked?

A Yes, sir, that's exactly how I designed Simulation Set No. 2. I mandated that all 13 districts had to contain one and only one of the 13 incumbents each, and I found that was very straightforward to do. It was very easy for the computer 1,000 out of 1,000 times to protect all 13 of the November 2016 incumbents in each -- in each of their own respective districts, meaning that none were double-bunked or none were paired.

Q And were you able to determine whether this additional constraint imposed on your simulations significantly altered the partisan distribution of seats you would expect under those simulations?

A I was able to make that determination. I found that it had no impact at all.

Q And I would ask you to look at Figure 4, which appears on page 16 of your report.

A Yes, sir.
Q And again you were presenting results based on the Hofeller formula and the 20 elections specified in the Adopted Criteria, is that correct?
A Yes, sir. Just like the last figure, the left side has results using the Dr. Hofeller formula. The right side has results using the 20-elections formula laid out in the Adopted Criteria.
Q And because the Court is familiar with this format from the earlier figure, I just quickly want to review the results from these simulated plans. Applying the Hofeller formula, what do you find is the most likely partisan distribution of seats for Simulation Set Two?
A Over 50 percent of the time the Simulation Set No. 2 creates seven Republican districts -- seven Republicans and six Democratics among the 13 districts. So seven Republicans is the most likely outcome.
Q And the SB2 Enacted Plan creates how many Republican districts using that definition?
A Using the Dr. Hofeller formula, the SB2 Plan creates ten Republican districts, and this is an outcome that is never seen in any of the 1,000 simulated plans here in Set No. 2.
Q And how likely is a nine Republican, four Democrat outcome?
A A nine Republican plan occurs only 1 percent of the time,

so it is still an extremely unlikely outcome. It occurs a very small percentage of the time.

Q And using the Adopted Criteria elections, what do you find is the most likely outcome in terms of partisan distribution of seats?

A The most likely outcome here, again, using the Adopted Criteria formula is six Republicans seats, six Republicans and seven Democrats among the 13 districts.

Q And how likely is it to yield ten Republican and three Democratic seats?

A It never yields ten Republicans. Zero out of 1,000 times.

Q Did it ever yield nine Republicans?

A It never does. Zero out of 1,000 times.

Q And how frequently does it yield eight Republican seats?

A Only a very small percentage of the time, 2.7 percent. In other words, 27 out of 1,000 times.

Q So from these results, were you able to determine whether the protection of all 13 House incumbents made the creation of a 10-3 Republican advantage in the SB2 Enacted Plan a plausible outcome?

A I was able to make that determination. I was able to conclude with very strong statistical certainty that even if the map drawer had been motivated by the concern of or by the factor of trying to protect all 13 incumbents as mandated by the Adopted Criteria, even such an extreme effort would not

have justified or explained or necessitated the creation of an enacted districting plan with as extreme of a partisan outlier as what we see in the SB2 Plan.

Q And directing your attention to Figure 5 on the next page, were you also able to determine whether this additional constraint affected performance as to other features of the Adopted Criteria, such as compactness?

A Yes. As before, I evaluated these 1,000 simulated plans along the measures of geographic compactness, as well as the number of county splits. So here in Figure 5 on the left side, this figure is just like the one we saw a couple of minutes ago, except now for Simulation Set No. 2 I displayed here the Reock score and the Popper-Polsby geographic compactness score of all 1,000 of the simulations, and I've compared that again with the compactness scores of the SB2 plan. And once again what we're seeing here is that the SB2 plan is creating a geographic compactness score that is completely outside of and significantly far below all 1,000 of the simulated plans.

Q So from that are you able to determine whether the protection of all 13 House incumbents required subordinating any of the other nonpartisan portions of the Adopted Criteria, such as compactness?

A What I'm seeing here in Figure 5 is that the geographic compactness of these 1,000 simulations in Set Two is largely the same, substantially the same as what we saw in set one.

What that allows me to conclude is that it's very clear that even heeding the Adopted Criteria's mandate of protecting all 13 incumbents would not justify or explain or necessitate subordinating geographic compactness to the extent that the SB2 Plan does. In other words, the protection -- the possible desire to protect incumbents does not explain the SB2 Plan's drawing of noncompact districts.

Q And is that conclusion summarized at the bottom of page 18 of your report?

A Yes, sir, it is.

Q Simulation Set Three, what was the purpose of the third set of a thousand simulations?

JUDGE OSTEEN: I'll tell you what. Hold on just a second.

MR. THORPE: Absolutely.

JUDGE OSTEEN: How much longer do you think you've got? Fifteen?

MR. THORPE: Ten to 15 minutes.

JUDGE OSTEEN: All right. Let's take about a 15-minute recess.

(At 3:30 p.m., break taken.)

(At 3:52 p.m., break concluded.)

JUDGE OSTEEN: Before you resume examination, let me tell everyone that when we get to the end of today's proceedings, I know we're -- adjusted on the fly in terms of

the presentation of evidence, and some witnesses -- there may be some difficulties getting here.

Right now, it's kind of -- having heard the first two expert witnesses, it's a little bit difficult to forecast how long an expert witness may be testifying. And so contrary to what I said earlier today, I think we better take the witnesses when they come in instead of stacking up for several on Thursday; and if, as we anticipate, we should be able to get all the evidence in Wednesday or Thursday if we need to wait on the expert from Arizona, then I would hope that Thursday afternoon, at the latest two, we could at least get started with a couple of hours of closing arguments. Two hours in total is what we're kind of thinking about right now.

You don't need to say anything just yet or agree to it, but I want you to think about what we're thinking about in terms of scheduling, and then we'll talk about it a little more at the end of -- at the close of business today, and we'll finalize it in the morning maybe or something like that. All right.

JUDGE BRITT: When you're thinking about your final arguments, you might also keep in mind that we're going to want you to file posttrial briefs.

JUDGE OSTEEN: All right.

BY MR. THORPE:

Q Dr. Chen, before our break, we were just about to discuss

Simulation Set Three. How does the third set of a thousand simulations that you created differ from the first and second set?

A This third set of simulations I wanted to ask a completely different -- a very different sort of question. What I wanted to ask here is the following. We've discussed today some of the aspects of the SB2 Enacted Plan, specifically, that it split 13 counties rather than the 12 that I found was very reasonable, and I also found that it protected only 11 incumbents rather than all 13. So what I wanted to ask here in Simulation Set No. 3 was whether the General Assembly's choice to draw a less than optimal plan with respect to 13 county splits rather than 12 and to only protect 11 incumbents might somehow explain the extreme partisan advantage, the 10-3 partisanship, of the SB2 Enacted Plan.

Q Would it be correct to say that for both Simulation Set One and Simulation Set Two, understanding that there's a difference with how you treat incumbency, that you were trying to maximize adherence to the nonpartisan criteria within the Adopted Criteria?

A Yes, sir, that's correct. In Set One and Two, I was trying to maximize adherence to the nonpartisan portions of the Adopted Criteria that we talked at length about today.

Q Does Set Three attempt to maximize adherence to the Adopted Criteria?

A Not with respect to county splits and not with respect to incumbents. So what Set Three does instead is it intentionally splits apart 13 rather than trying to minimize the number of counties split. It intentionally splits 13 counties rather than 12, and it intentionally protects only 11 incumbents, no more and no less. So exactly the same number of incumbents as protected in the Enacted SB2 Plan.

But on all other nonpartisan portions of the Adopted Criteria, meaning VTD splits, geographic compactness, equal population, et cetera, I am in Simulation Set Three otherwise, aside from counting splits and incumbency protection, simply -- as before, I'm otherwise trying to maximize adherence or strictly adhere to the nonpartisan portions of the Adopted Criteria.

Q And just to be clear, you instructed the computer to create simulated districting plans that would yield 13 county splits and 11 protected incumbents?

A Yes, sir, exactly, even though that is less than optimal. Even though 13 county splits is not optimal, I intentionally did that; and, again, I intentionally did that to ask this very specific hypothetical question: Could the General Assembly's choice to split 13 counties and protect only 11 incumbents -- somehow could that unique combination of features justify or explain the enacted plan's creation of an extreme 10-3 Republican advantage.

Q And if I could have you turn to page 21 of your report, which is Figure 6, what did -- what does Figure 6 show with respect to the partisan distribution of seats under the third set of simulations?
A Figure 6 is exactly laid out just like the other two diagrams -- similar diagrams we saw just before the break, except here I'm describing Simulation Set Three. And this, again, tells us, among those 1,000 simulations, in Set No. 3 this time, how many created six Republican seats, how many created -- how many plans created seven Republican seats, how many plans created eight Republican seats. What it shows us is that the most likely outcome under this third algorithm is the creation of seven Republican seats -- seven Republican and six Democratic seats.
Q And you are referring here I believe to the chart on the left side which uses the Hofeller formula for those elections?
A Yes, sir. I was just talking about the left figure here referring to the results calculated using Dr. Hofeller's formula. I haven't gotten to the right side yet.
Q And using Dr. Hofeller's formula, the likeliest outcome was the election of seven Republicans based on vote share as you've been calculating it throughout your report?
A Yes, sir. Using Dr. Hofeller's formula for again measuring the partisanship of districts, most of the time, over 50 percent of the time -- so 53 percent of the time this third

set of simulations creates exactly seven Republican and six Democratic districts, and we see that in the vast majority -- virtually all of the simulations create either five, six, seven or eight Republican seats.

Q And in this set of a thousand simulations, all of which have 13 county splits and protect 11 incumbents, how frequently does a 10-3 split in favor of Republican vote share occur?

A Never. In zero out of 1,000 times. Never do we actually have a ten Republican map.

Q And, again, using the Hofeller formula, how frequently does a nine Republican seat advantage occur?

A Results are very similar to what we see in the previous simulation sets. It never occurs. We don't ever have a plan with nine Republican seats using the Adopted Criteria formula for measuring partisanship. That's what we see on the right figure.

Q On the right figure, you are referring to the use of the 20 elections?

A Yes, sir.

Q Okay. And in those 20 elections, you're testifying that you never see nine and you never see ten districts with a -- with more Republican than Democratic votes using those elections?

A Yes, sir. So let me just go back and answer a little bit more precisely. When we use -- on the right side when we use

the 20 Adopted Criteria elections, we see that never does a simulated plan create nine or ten Republican seats. Now, on the left figure, the one using the Dr. Hofeller formula, nine out of thirteen Republican districts is an outcome that occurs a little bit under 1 percent of the time. So less than 10 out of 1,000 times do we ever see a nine Republican seat plan using the Dr. Hofeller formula. But to go back to the right figure, using the Adopted Criteria formula, we never see even a nine, much less a ten, Republican seat plan.

Q Understood. Throughout these histograms, you have displayed where the SB2 Enacted Plan falls along the likely number of seats, is that correct?

A Yes, sir.

Q And I just want to be clear about what you're using to yield that result. We know now in retrospect that there are ten Republicans that have been elected to the House of Representatives, correct?

A That's correct. But just to answer the question, when I wrote that red line out there, that red dashed line that says "SB2 Enacted Plan," that is not based on, say, the number of Republicans that were elected to North Carolina's congressional delegation in 2016 or in any other year. That is --

Q So just to be clear, it is not based on your evaluation of how many elections were actually won. It was based on the application of the same data, whether the Hofeller formula or

the Adopted Criteria elections to the same set of data?
A Exactly correct, sir. What I wanted to do in these figures -- in all of these figures, like the one we see here, is an apples-to-apples comparison on the left using Dr. Hofeller's formula in evaluating all of my simulated plans, and then use Dr. Hofeller's formula in evaluating the SB2 Plan. So that's what makes it an apples-to-apples comparison here, using the same partisan metric that Dr. Hofeller gave to me.
Q Is there any circumstance in which Dr. Hofeller's formula yielded a Republican -- a number of districts other than ten where Republican votes exceeded Democratic votes?
A You're asking about the SB2 Plan?
Q Um-hum.
A No, it calculated ten Republican districts under the Dr. Hofeller formula.
Q And using the Adopted Criteria elections, is there any circumstance in which the elections specified by the Adopted Criteria yield anything other than ten seats in which the Republican vote share exceeds the Democratic vote share?
A No, sir. I had all the elections -- for the 20 elections mentioned in the Adopted Criteria, it's very straightforward to apply those and evaluate the SB2 Plan, and it was very clear that using the Adopted Criteria formula the SB2 Plan has ten Republican seats and three Democratic seats.
JUDGE OSTEEN: Let me make sure I understand this.

So the red line on the right side of each of the charts is not the actual SB2 result.

THE WITNESS: Your Honor, it represents the number of districts that using Dr. Hofeller's formula or the Adopted Criteria formula are Republicans. So it does not actually reflect the actual congressional delegation elected in 2016 or in any other year. So it is not reflecting actual congressional election results. It is reflecting Dr. Hofeller's formula.

MR. THORPE: Would I be correct -- and, hopefully, Your Honor, this --

JUDGE OSTEEN: Let me think about this just a second before we -- so are you saying it's taking Dr. Hofeller's formula and putting it in one of your plans?

THE WITNESS: No, Your Honor. What I did is I just evaluated the 13 districts in the Enacted SB2 Plan, the 2016 SB2 Plan, and I looked at that districting plan and its 13 districts, and I calculated for every one of the 13 districts how did Dr. Hofeller's formula evaluate the partisanship of that enacted SB2 district. I did that for all 13 districts, and I counted that Dr. Hofeller's formula would have classified 10 of those 13 districts as being Republican districts. They are, incidentally, the same 10 districts that elected Republican candidates in 2016, but that was just my application of Dr. Hofeller's formula.

BY MR. THORPE:
Q And I'll ask sort of a different version of the question and hope to make that a little bit more clear. The SB2 Enacted Plan that is reflected on all of these charts is not something that, in hindsight, you said, well, the Republicans won ten seats, so I'm going to put them all at ten; is that correct?
A That's correct, sir. I didn't just put ten there simply because we know that there are ten Republicans elected. That was -- that was not what I did here.
Q Instead, you used the actual districts as constructed under the 2016 Plan and applied the same data that you used to evaluate your simulated districts to determine the Republican vote share for both the simulated districts and the enacted plan?
A Correct, sir. That's what we need for an apples-to-apples comparison here. So, again, I just took the enacted plan, the actual districts of that enacted plan, and I overlaid -- because this was easily publicly available data. I overlaid the results from all of those 20 Adopted Criteria elections that we discussed some time ago. I overlaid them and calculated how did the Adopted Criteria political data evaluate the partisanship of the districts of the enacted plan, those actual 13 districts of the enacted plan. And I went through those 13 actual districts of the Enacted SB2 Plan one by one and said how does the Adopted Criteria evaluate the

partisanship of this district given that the Adopted Criteria already gives us a very specific set of elections to be used in evaluating the partisanship of the districts.

Q And it was your testimony a few moments ago that the districts in which you found Republican vote share exceeded Democratic vote share were, in fact, the same districts in which Republican candidates prevailed in 2016?

A Yes, sir, that's correct.

Q I want to turn your attention to Table 1, which appears on page 12 of your report. And we don't need to go through this in detail because we've largely discussed the information included in it, but is it accurate to say that Table 1 summarizes the simulation set approaches that we have discussed and the results that you -- these simulations yielded?

A Yes, sir. So it's, again, a comparison of Simulation Sets One, Two, and Three, which we've now discussed, and a comparison of those three simulation sets to the Enacted SB2 Plan, and I'm comparing all of these simulations to the Enacted SB2 Plan on a number of nonpartisan criteria listed in the Adopted Criteria.

Q And how does Table 1 display the partisan distribution of seats under both the enacted plan and the various simulation sets?

A So let's go to the very bottom of Table 1, that bottom row, that bottom row there where I've labeled it "number of

Republican districts under the Hofeller formula." And just to go back again to what we were talking about a minute ago, I, of course, calculated the SB2 Plan using Dr. Hofeller's formula; and I found that in the SB2 Plan there are ten districts out of 13 that Dr. Hofeller's formula counts as Republican districts. And I did the same formula -- applied that same formula to all three sets of simulations, to all 1,000 plans, maps, in these three sets of simulations, and I counted up in, say, Simulation Set No. 1, how many plans have exactly five Republican districts, how many plans have exactly six Republican districts.

This is all information that we already reviewed earlier in those histograms and those figures we went through a while ago, but it's laid out here in numerical form again here in this bottom row. So it's telling us that for Simulation Set No. 1 the range of Republican districts calculated using the Hofeller formula is always between 5 out of 13 up to 9 out of 13 Republican districts using the Dr. Hofeller formula; and, of course, that is compared to the ten Republican districts using Dr. Hofeller's formula as calculated in the SB2 plan.

Simulation Set Two, that next column over, is another comparison. It tells us that all of those simulated plans in Simulation Set No. 2 are creating between nine to five -- or five to nine Republican districts; and as we said earlier, most of them are about seven Republican districts. So over half of

them are creating exactly seven Republican districts under the Dr. Hofeller formula.

Go to the next column, Simulation Set No. 3. It tells us another distribution like that. Here we see that in this bottom row in the very right column of this Table 1 -- what this Table 1 tells us there is that in Simulation Set No. 3 the entire range of the partisan seats in these 1,000 simulated plans, these 1,000 districting plans in Simulation Set Three, ranged from four to nine Republican seats; and, again, most plans had six or seven Republican seats, but the entire range went out as low as four and as high as nine, never to ten.

Q What then does Table 1 tell us or summarize about whether, in your 3,000 simulations, there will be conditions that could emerge that would explain a 10-3 Republican plan?

A Well, we evaluated -- or I evaluated a number of different possible explanations or possible alternative explanations for what might possibly justify; and as I said before, in Simulation Set No. 3 I was asking, well, is it possible that the General Assembly's choice to create exactly 13 county splits rather than minimize that number and the General Assembly's choice to protect exactly 11 incumbents, if that unique combination of features could somehow justify or explain or necessitate the creation of a 10-3 Republican map. What these simulation results, as described here in this table,

allow us to see pretty clearly is that such unique combinations of features of the Enacted SB2 Plan do not somehow necessitate or justify or explain why it was necessary to create an Enacted SB2 Plan with a 10-3 Republican advantage.

In other words, what it's showing here is that even if you had wanted -- for whatever reason, even if you had really wanted to create a plan with 13 county splits and just protect 11 incumbents but otherwise follow strictly the nonpartisan portions of the Adopted Criteria, even then with that unique combination you still would have ended up with a plan that generally creates six or seven Republican districts under Dr. Hofeller's formula, occasionally five and occasionally up to eight, but certainly never ten.

Q And so I want to be very clear about what this explains. You've referred to certain unique features of the Adopted Criteria and of the enacted plan. To be clear, does your approach account for the political geography of North Carolina voters and where they reside?

A Accounting for political geography of North Carolina voters was very much at the heart of the motivations for conducting all these sets of simulations. The whole point here is that what the computer is doing is it is taking North Carolina's voter geography, as laid out across all of North Carolina's counties and VTDs and census blocks, and starting with those census geographies, given their unique distribution

of partisan voters, their unique distribution of Democrat and Republican voters, and saying given those sets of geographies with that particular unique geography of North Carolina, what happens when we build districting plans in North Carolina that strictly comply with the nonpartisan portions of the Adopted Criteria. And so accounting for North Carolina's voter geography is at the very heart of what this analysis is doing.

Q And so are you able to conclude from this analysis that the Enacted SB2 Plan creates a partisan distribution of seats that falls entirely outside the range of outcomes possible in the absence of the partisan criteria in the Adopted Criteria?

A Yes, sir, that's exactly right. What I'm finding here is that regardless of which of these two measures of partisanship that one uses, whether we use Dr. Hofeller's way of measuring the partisanship of districts or the Adopted Criteria of elections for measuring the partisan distribution of seats, one, we see that the SB2 Plan has created ten Republican districts using either one of these measures.

Second, we see that the SB2 Plan's creation of ten Republican seats is an extreme statistical outlier in terms of its partisanship, whether measured by Dr. Hofeller's formula or by the Adopted Criteria of elections. It's creating an extreme statistical outlier in terms of its partisanship, and that statistical outlier is entirely outside of the entire range of the sorts of plans that would have emerged under a districting

process that strictly adhered to the nonpartisan portions of the Adopted Criteria.

Q I will be mindful of the Court's decision to grant the motion in limine and respect that aspects of what I'm about to discuss are principally going to be introduced by the League of Women Voters Plaintiffs, but on page 23 you begin a section that leads to the end of your report that is entitled "Robustness Checks Using Alternative Measures of Partisanship." Is that correct?

A Yes, sir, that's correct.

Q And speaking generally, what was the purpose of this section of the report?

A Generally, I wanted to conduct some robustness checks that would test and confirm the results in the main part of my report, which is everything that we've discussed up until now, the first main part of my report.

So this second section, this latter section of my report, presents a number of robustness checks that use alternative measures of partisanship of districts, meaning alternative measures in addition to and separate from, completely different from, the measures that we've been talking about with Dr. Hofeller's formula and the Adopted Criteria formula.

The reason I wanted to present these alternative robustness check measures of partisanship is that these are

measures that are commonly used by scholars of redistricting, scholars who study -- study legislative districting and congressional district elections, and so I wanted to make my findings accessible and relatable to scholars that use some of these various methods that come up in the scholarly literature. So that's why I presented the robustness checks.

But they're not -- they're not robustness checks that are meant to serve as the foundation of what I do in the main part of the report. They're just there to make the findings more accessible and relatable to scholars that use these alternative robustness checks in the literature.

Q And that's really the question I want to ask. Is there anything in the section that begins on page 23 that is necessary to explain the findings that are included in the earlier sections of the report?

A No, sir. The earlier findings in the earlier section that we've discussed up until now, that earlier section speaks for itself. What I'm doing here is making those findings more relatable and to relate them to scholars that have used alternative measures of partisanship using these various robustness checks.

MR. THORPE: With the understanding that that will be a portion of direct testimony from the League of Women Voters Plaintiffs tomorrow, those are all the questions I have. Thank you, Doctor.

THE WITNESS: Thank you, sir.
THE COURT: Any cross at this time?
MS. RIGGS: Good afternoon, Your Honors. I just want to confirm that, following the granting of the motion to bifurcate, we'll be reserving our questions for Dr. Chen for tomorrow and we'll go into details --
JUDGE OSTEEN: In terms of the other --
MS. RIGGS: The rest of the material in his expert analysis will be, I think, more -- will be better presented to the Court after Dr. Jackman --
JUDGE OSTEEN: Let me phrase it this way. Have you got any questions about anything he's testified to so far?
MS. RIGGS: Not specifically. I think that it will be better framed in the context of the way I've -- the rest of the report. So the rest of the report uses the same simulations that he used before. So it will come up again a little bit, but I anticipate our -- when we recall him, it will be much more brief.
JUDGE OSTEEN: All right. A lot more brief, very narrow.
Cross-examination?
MR. STRACH: Yes, Your Honor.

CROSS-EXAMINATION

BY MR. STRACH:
Q Good afternoon, Dr. Chen.

A Good afternoon, sir.
Q You and I have never met. I'm Phil Strach. You had a deposition taken with a colleague of mine, so it's good to finally meet you.
I just want to ask a general question before I get into too many detailed questions. My understanding is with regard to these simulation sets that you ran that you did so -- your purpose of doing that was trying to assess the redistricting plans strictly on the basis of nonpartisan criteria, is that correct?
A Well, in Set No. 1, that was the case. As I had discussed some time ago, Set No. 2 and 3 were a little bit different and did bring in some various partisan-related considerations. But you're right in describing Set No. 1 that way, sir.
Q All right. And then even in the other two sets, the only partisan considerations you brought to bear were nonpairing of incumbents, correct?
A Specifically, the number of incumbents that were placed into districts of their own, but I think you're getting at the right idea there.
Q Right. And even with respect to incumbents, you did not consider whether the incumbent could win their district, just whether they had a separate district to run in, correct?
A I strictly followed the Adopted Criteria when it told me that incumbents are to be avoided -- are to be not

double-bunked, are not to be paired. So that's how I interpreted -- or that's how I read that portion of the Adopted Criteria.

Q Right.

A You're asking if I considered, say, the partisan makeup of the resulting districts, and the answer is no. I followed the Adopted Criteria and what it told me about the protection of incumbents.

Q Right. And so other than the pairing of the incumbents -- the only point I'm trying to make is other than the actual pairing of incumbents, you were assessing or trying to assess these districts on the basis of nonpartisan criteria, correct?

A That's correct, sir. Aside from the incumbent issue that we were just talking about, I otherwise was just following the nonpartisan portions.

Q All right. So your analysis assumes that there would be a rule in place that politics could not be considered in the construction of districts. That's what your analysis helps the Court to look at, correct?

A Well, I don't know if I make that assumption. What I do is I ignore the partisan portions of the Adopted Criteria when the Adopted Criteria tell us you have to create ten Republican districts.

Q All right.

A So I'm dropping that part.

Q Okay. And so to the extent that the consideration of politics is an appropriate consideration in redistricting, your report does not assess or try to study how much politics would be too much?
A Sure, I don't -- I mean, I think -- I don't take any position on the extent to which politics is or is not an appropriate consideration. What I'm conducting is an empirical study here, and it's just limited to answering what are the sorts of plans that would have emerged if you had solely followed the nonpartisan portions of the Adopted Criteria or if you had followed the nonpartisan portions, plus the incumbency portion, the incumbency criteria.
Q Okay. And then looking back briefly at your Table 1, which is page 12 of your report?
A Yes, sir.
Q When you're looking at the bottom row, which is the number of Republican districts under the Hofeller formula?
A Yes, sir.
Q And it's -- I think you've testified and I think it's fair to say that generally the outcome that pops up the most in these is Republicans electing six or seven members out of 13, correct?
A Yeah, that's correct. Mostly six and seven and sometimes eight. Those are certainly the most common outcomes that we see here in the bottom row of Table 1.

Q And is it true that Republicans electing six or seven would be closer to their share of the number of members if we were electing members of Congress based on proportional representation?
A I don't know that I've ever done that calculation, so I can't give you the precise number or whether or not your math is accurate on that.
Q If the Republican share of the vote for Congress in 2016 was about 53 percent, out of 13 districts wouldn't it stand to reason that they would elect at least seven if you were going on proportional representation?
A Well, see, sir, your question there represents an apples-to-oranges comparison because what I just presented here in the bottom row of Table 1 is a calculation using Dr. Hofeller's formula. So you just -- I think you just used actual congressional election results in giving me a basis for forming a proportional question. So I'm not sure that that's a valid way of evaluating a proportional representation calculation.
Q Okay. But when you study the use of -- when you study the outcomes based on the so-called nonpartisan criteria, you just happen to typically end up with an analysis that would result in numbers that are close to six or seven Republicans?
A That's correct, sir. I mean, I certainly don't pay any attention before that final calculation of the partisan results

to what sort of representation this would mean for the Republicans or the Democrats, and I certainly am not designing the algorithm to be at all interested in whether or not representation is proportional. That would be completely outside of what I set out to do here.

Q All right. And just in general, Dr. Chen, have you ever -- we asked Dr. Mattingly about this. Have you ever used Maptitude redistricting software?

A I've briefly used it. It's not part of my normal research practice or my normal research process. But, obviously, I'm -- you know, as anybody who works in redistricting, I'm, of course, familiar with it and have used it just briefly, but it's not what I primarily use.

Q All right. And you've never -- you've never been engaged to draw an actual redistricting plan in real life, correct, in terms of for a legislature or for a client?

A Well, I would -- I think -- I mean, I just want to answer your question as accurately as I can here. I have in this expert report produced lots of districting plans, so certainly I've produced plans.

Q You've never been engaged to draw a plan that would actually have to win enough votes to pass an elected body, have you?

A No, I don't think so, no. No. I mean, I think what you're asking is if I've ever drawn one for a legislative body,

right? And the answer is no.
Q Okay. And, in fact, your analysis really doesn't consider at all whether any of the maps that your computer draws could actually ever be adopted by a political body, does it?
A My expertise doesn't extend to evaluate that. My expertise here is in simply taking the Adopted Criteria and saying here are plans that strictly comply with the nonpartisan portions of the Adopted Criteria. Whether or not the North Carolina State Legislature would ever willingly adopt any one of those plans that comply with the nonpartisan portions of the Adopted Criteria, that's totally beyond me.
Q All right. Let me take a look at -- may it please the Court?
JUDGE OSTEEN: Are these all the same?
MR. STRACH: Yeah, they should be.
JUDGE OSTEEN: Just one copy of Chen Simulation Set One Plan One? That's what we're looking at?
MR. STRACH: Yes, Your Honor.
JUDGE OSTEEN: Okay.
BY MR. STRACH:
Q Dr. Chen, I will represent to you that using your data we've generated Plan One out of your Simulation Set One. This is -- we picked this one just because it was the first one in the first set, and this is the map that was generated, much like the map that you've generated that you talked about

earlier. Do you have any reason to doubt whether or not this is an accurate representation of the very first plan that your set developed?
A No. I accept that, sir.
Q All right. For instance, just talking about real-world consequences of a map like this, do you see where District 9 is on this map?
A Yes, sir.
Q And do you see who the incumbent is in District 9?
A It appears to be Butterfield, sir.
Q All right. Do you know Congressman Butterfield? Do you know of him?
A No, sir, I don't.
Q Do you have any idea whether Congressman Butterfield would be able to win the district that is drawn for him, District 9, in this map?
A I definitely would not have analyzed that question because the Adopted Criteria did not instruct me to analyze that question, sir.
Q All right. If you look up at District 10, do you see District 10?
A Yes, sir, I do.
Q And it appears to me that district stretches from Ashe County in the west all the way over to Hertford in the east. Does that look accurate to you?

A Yes, sir, that sounds right.
Q Do you have any idea whether any legislature, Democratic or Republican, would ever pass a map that had that district?
A I'm sorry. If I could ask you to repeat.
Q Well, let me ask it to you this way. Do you have any knowledge of North Carolina communities of interest in Ashe County versus North Carolina communities of interest in Hertford County?
A Well, sir, my only understanding of communities of interest is the way that the Adopted Criteria defines them, and it defines them in terms of VTDs and counties, and so that's my only understanding of communities of interest in North Carolina.
Q All right. And you have no idea whether any legislature in North Carolina would ever actually adopt a map containing a district that went from Ashe County to Hertford County, do you?
A That's definitely not something I would have analyzed because the Adopted Criteria didn't tell me to analyze that question.
Q All right. And why don't we have this map -- this is something we'll talk a little bit more about later while we're looking at this map. Do you see Onslow County on this particular map?
A If you could orient me and maybe point me to it.
Q Onslow County, if you look at southeastern North Carolina,

borders the ocean.
A Okay. I got you. I see it there.
Q Okay. And if you will note that District 11 juts into Onslow County two different times, is that correct?
A I can see that, yes, sir.
Q Do you have any understanding in North Carolina redistricting of what is called a "traversal"?
A Are you referring to "double traversal," I think, sir?
Q This is a double traversal, isn't it?
A Yes, sir. I understand what you mean by that term.
Q Okay. All right. We'll talk about that a little bit later. Now, also let me just make sure I understand. You studied the 2016 Congressional Plan. You did not study whether the 2011 Congressional Plan was politically gerrymandered or otherwise, did you?
A I did not study the 2011 Plan for this expert report, no, sir.
Q All right. And did you conduct the analysis in this report after the 2016 Plan had been passed?
A Yes, sir. I think it was entirely after it had already passed.
Q All right. Did you sit in on any of the legislative proceedings that caused the enactment of that map?
A No, sir, I didn't.
Q And afterwards -- well, did you look at the 2016 enacted

map?
A Oh, sure. I looked at it in my analysis.
Q All right. And did you actually take a physical copy out and look at the way the districts were shaped and what they looked like on a physical map?
A Well, I certainly looked at it on the computer screen. I think -- we don't real commonly print out everything that we -- or even many of the maps we look at now, but I certainly looked at it in a hard copy form on my computer screen.
Q All right. Did you obtain a copy of the transcripts of the legislative proceedings that produced the 2016 map?
A No, I didn't.
Q So I take it you didn't study or otherwise review the legislative debates that produced that map?
A No. Doing so definitely would not have been part of what I needed to accomplish for my research process here.
Q All right. In looking at the 2016 map itself, did you try to identify which counties the General Assembly chose to split -- as opposed to the fact that they split 13, did you try and identify which ones were split?
A Well, the Adopted Criteria don't tell me to favor or disfavor any individual particular counties in deciding which ones to split. It only tells me to minimize, to not split them unless necessary. So I definitely would not have paid attention to whether we were favoring this or that county when

splitting up counties.
Q Did you happen to recognize whether all the -- whether most or all the split counties in the 2016 map were actually large counties that were split?
A I followed the Adopted Criteria strictly, which means that I simply counted the number of counties that were split. That's all the Adopted Criteria told me to pay attention to.
Q All right. And you don't know if in the legislative history on this there's any indication that the legislature wanted to split larger counties as opposed to smaller counties?
A That definitely would not have been relevant to my task in this report, so I did not do so.
Q And if a legislature decided to split big counties rather than small counties, would you agree with me that would be a political consideration they would be making?
A If the legislature had put in a criterion favoring the splitting of big counties rather than small counties, would that have been a political consideration? I just want to make sure I understand the question.
Q Would a decision, any decision, to split big counties rather than small counties be a political consideration in your estimation?
A It's not quite the same thing as saying create ten Republican districts. However, that is the sort of favoring or decision that may very well have some important political

impacts on maps that emerge, but when -- I emphasize it's not a question I specifically studied because the Adopted Criteria did not tell me to pay any attention to the population of the counties that were split.

Q The Adopted Criteria did say, though, that political considerations would be taken into account in splitting counties, correct?

A Well, just to be clear, what I did in my report was to ignore the partisanship criteria. Now, the partisanship criterion, as laid out very clearly in the Adopted Criteria, is create ten Republican districts.

So I think what you're referring to is the paragraph on compactness that talks specifically about the reasons that counties may be split up. And so I interpret that sentence to mean that gives three reasons why counties may be split up because it's telling us that counties may be split up to equalize population, obviously, and protect incumbents; but the third one means that if you are trying to achieve a 10-3 Republican advantage, then you can split up counties. That's how I read that sentence, which is what I think you're referring to.

Q And the actual words are: Division of counties to be made for reasons of equalizing population, consideration of incumbency, and, quote, political impact, correct?

A Yes, sir. That's exactly what I was referring to and what

I was just trying to explain a minute ago was that my understanding of what the Adopted Criteria means by "political impact" is its explicit pursuit of a ten Republican map.

Q That's your assumption of what those two words mean, correct?

A No, I just read the words on the Adopted Criteria. The Adopted Criteria are telling us build a ten Republican map, and that is what clearly is meant by political impact.

Q All right. And so if legislators decided that they wanted to make a political decision to split big counties and not little counties, you're telling me the words "political impact" could not include that concept?

A No, I understand what that sentence to mean is that that is a clause that allows the legislature, if it's strictly following the partisan portions of the Adopted Criteria, to split counties in order to create a 10-3 Republican map. Doing so might possibly be consistent with the kind of attention paid to large counties versus small counties that you just alluded to, but that's not something that I would have analyzed for my report because because that was irrelevant for my task in my report.

Q Would there be any -- would there be anything wrong, in your estimation, if a legislature did decide to split only bigger counties rather than smaller counties to ensure the smaller counties' representation wasn't adversely impacted?

A By "wrong," you mean that I personally wouldn't have liked it?
Q Right.
A I don't take a view on that. My role in here was purely to conduct empirical analysis and I take no position on what the North Carolina legislature should or should not do.
Q All right. Now, remind if I get any of this wrong. In at least one of your simulations, you attempted to generate plans that minimized the number of counties split, is that right?
A That is correct. In Simulation Set No. 1, I was attempting to keep counties whole when possible; and also in Simulation Set No. 2, I was doing so again in the same way.
Q All right. So in two of your simulation sets, is it fair to say you were trying to maximize the number of whole counties?
A I was trying to keep counties whole and only split them when necessary to achieve population equality, which is, again, taken straight from that sentence that you and I were just talking about about two minutes ago.
Q All right. But you would agree with me that the actual Adopted Criteria nowhere says that the legislature would try to maximize the number of whole counties?
A Oh, I think it's very clear from the sentence that you and I were just talking about a minute ago that if you read that sentence of when counties can be split the Senate lays out

three reasons.

In the first simulation set, I ignored the political reasons. Now, if you take out the political reasons, what's left in that sentence, it says that counties can only be split to equalize population. Now, applying that to Simulation Set No. 1 or 2, in general the only times that you need to split a county in order to achieve equal population are as we illustrated or as I illustrated quite some time ago with Mr. Thorpe, at the beginning and the end of the building of any district. Every additional district that you add you just need to split one additional county in order to achieve equal population.

So that was a pretty clear part of the Adopted Criteria for me. I only split counties when necessary to achieve equal population. It's a pretty straightforward redistricting matter that if you have a certain number of districts, say 13 districts, you only need, at most, to split 12 counties if your goal is to only split counties when necessary for equal population. So 13 counties means 12 split counties -- 13 districts, sorry, means 12 split counties are needed to achieve equal population, and so that's what I did in Simulation Sets One and Two.

Q All right. So you ran your simulations based on your reading of this criteria which lopped off the last two phrases of the sentence, correct? You took out the part about

incumbency and political impact, and you read it to say we can only split a county to equalize population.

A Absolutely. In Simulation Set No. 1, again, as I described earlier, I was trying to only pay attention to the nonpartisan portions of the Adopted Criteria. The last half of that sentence is an explicitly partisan portion of the Adopted Criteria, so I ignored that. I ignored the partisan mandates of the Adopted Criteria and just said, Let's try to comply as much as possible with the nonpartisan portions of the Adopted Criteria. That's what the simulations do.

Q Let me ask you this because there's another part of this criteria on compactness that I don't think we've talked much about. The first sentence says: "...the committee will make reasonable efforts to construct districts in the 2016 Contingent Congressional Plan to improve the compactness of the current districts and keep more counties and VTDs whole as compared to the current enacted plan."

Do you recall that part of the criteria?

A Yes, sir.

Q And did the 2016 Plan in fact split fewer counties than the 2011 Congressional Plan?

A It's not something that I personally analyzed because it wasn't necessary for the production of my report, but I certainly accept your presentation on that one.

Q So you didn't analyze that part of this criteria and how

it might affect your analysis?
A No. I mean, analyzing the 2011 Plan was not part of my research task here.
Q Even though -- even though the criterion said that what we're going to aim to do is split less counties than what we did in 2011?
A Yeah. Doing so was not part of my research process because the Adopted Criteria are pretty clear on what I'm supposed to do about county splits. You only split counties when necessary to achieve equal population. It's pretty clear.
Q So if the 2016 Plan in fact reduced the number of split counties compared to 2011, that would comply with this criterion even if it didn't minimize the number of split counties, isn't that right?
A That's possible, but it just wasn't relevant for me because, once again, what I paid attention to was the portion that told us when counties can be split. Again, I followed that and said counties can only be split to equalize population.
Q All right. And so I take it as a given then that you did not study or look at the number of county splits in congressional plans prior to 2011, like 1998, 2001, et cetera? You didn't look at any of those, did you?
A That's correct, sir. That would have been not relevant to my study.

Q So as you've noted, the enacted plan splits 13 counties, correct?
A Yes, sir.
Q Did you study or analyze whether the General Assembly could have created more Republican-leaning districts if it had split, say, 30 counties instead of just 13?
A Oh, I definitely didn't study that because it was not my task in evaluating the enacted plan's compliance with the Adopted Criteria. It obviously was not part of my task to go out and set out and try and draw extreme Republican gerrymanders like what you're -- I think what you're alluding to. So definitely not.
Q So I take it, too, when you were looking at the partisan makeup of the districts that resulted using either the Hofeller formula or the other formula, you didn't make any assessment of how strong a Republican or Democratic district that particular district was, did you?
A No. My task was very narrow here. What I did was I took Dr. Hofeller's formula at face value and, of course, I took the Adopted Criteria elections formula at face value because I wanted in part to measure how partisanship was understood by the map drawer, by Dr. Hofeller and by the Joint Select Committee. So that's why I followed their formula in assessing partisanship.
Q So you agree with me, don't you, just as a general

redistricting matter, that you can have either ten really weak Republican districts even though they lean Republican or you can have ten very strong Republican districts, correct?
A I mean, you're describing different plans. For one plan you're saying ten weak Republican districts and another plan ten strong Republican districts. I mean, I guess I accept that that's abstractly possible. I'm not answering with respect to whether that's possible in North Carolina specifically or steering to that in '16 -- with the 2016 Plan because I definitely would not have assessed that kind of judgment because that was definitely not part of my research task here.
Q All right. So you didn't -- you made no assessment of the strength of any one of those ten, quote, unquote, Republican districts?
A Again, the Adopted Criteria did not tell me to do so, so I did not do so.
Q Okay. And, in fact, you've not done any study of any individual district and whether, given the current incumbent in that district, that incumbent would win or loss the next election. You've made no attempt to do anything like that, correct?
A With the incumbents, the Adopted Criteria only told me to analyze whether or not they are paired, whether or not they are double-bunked, so that's all I did with incumbents. I did not do that because the Adopted Criteria don't tell me to do that.

Q All right. So you've done no individualized district-by-district assessment with the likelihood that Republicans going forward can hold any of those districts?
A Again, no, because that Adopted Criteria definitely did not tell me to consider that.
Q And you certainly didn't look at the political dynamics in those districts as to how much money was spent, strength of incumbents to make any assessment of the likelihood of these districts remaining Republican. You didn't do any of that, correct?
A Correct. Once again, the Adopted Criteria did not tell me to factor things like campaign financing dynamics.
Q Do you know if the 2016 Enacted Plan divided fewer precincts or VTDs than the 2011 Plan?
A I didn't evaluate the 2011 Plan along that dimension, so I can't tell you for sure.
Q All right. And even though in the compactness criterion it states that one of the goals was to keep more VTDs whole as compared to the current plan?
A I can see that portion that I think you're quoting from under the compactness paragraph, sir, yes, sir.
Q You didn't include that part in your study?
A Oh, I absolutely did. What I did was that I split VTDs only when necessary to achieve equal population and that is -- you know, that's something that comes up even more

fundamentally earlier on in the Adopted Criteria. The Adopted Criteria were very clear, told me VTDs can only be split -- quote, should be split only when necessary to comply with the zero deviation population requirement set forth above. So that's what I followed.

In doing so, obviously you're going to -- you're going to split fewer VTDs than the previous plan, or I'm assuming so, even though, as I said, I definitely didn't evaluate the VTD splits in the previous plan because the Adopted Criteria are so clear about when you are actually allowed to split VTDs.

Q Okay. Am I correct in saying that your study uses mathematical compactness tests to score the districts on a compactness basis?

A Yes, sir. Specifically, Reock and Popper-Polsby I think is what you're referring to.

Q All right. Do you know if those measures were used by the General Assembly in actual enacting the plan?

A I asked Plaintiffs' counsel about that, and Plaintiffs' counsel represented to me that Popper-Polsby and Reock were used by the map drawer.

Q You know that based on the representation of counsel?

A Plaintiffs' counsel represented that information to me, yes, sir.

Q You don't have any other independent basis for believing

that?
A No. I asked Plaintiffs' counsel.
Q All right. Did you take any look at whether or not the General Assembly, if they had looked at mathematical compactness, whether they could have drawn more Republican districts that were less compact? Did you attempt to analyze that at all?
A I just want to ask you to repeat or clarify the question. I think I heard two different things going on.
Q All right. If the General Assembly had used mathematical compactness scores, the same ones that you've described --
A Okay.
Q -- did you do any study to see whether or not if the General Assembly had drawn -- intentionally drawn less compact districts that they could have drawn more Republican districts? Did you see whether that was possible?
A You're saying more than ten?
Q Yes.
A I didn't set out in my simulation analysis to intentionally try and draw an even more extreme Republican gerrymander. So in that sense, no, I did not directly analyze that question.
Q You don't know whether ten Republicans and three Democrats is -- you don't know if that's the maximum Republican map that could be drawn?

A So I guess you're asking me whether or not if you drew really, really serpentine-shaped districts whether it might be possible to create an 11-2 plan and I acknowledge that's hypothetically possible. It was definitely not even something that was relevant to my study. I guess I acknowledge it's hypothetically possible, but I really couldn't tell you for sure one way or the other because I definitely was not trying to draw such extreme Republican gerrymanders.

Q And apparently the legislature wasn't either, right, because to do that they would have had to have ignored a lot of the traditional redistricting principles, wouldn't they have?

A I really couldn't tell you one way or another. I suppose it's hypothetically possible.

Q Could you describe for the Court what the -- what you call the Popper-Polsby compactness test is and what it does?

A Sure. So it's a very standard measure used by scholars of districting in measuring compactness, and it's just one of these couple of very commonly-used and very widely-used measures of compactness.

So the basic idea of Popper-Polsby is you're looking at this perimeter of a district -- of any one of the 13 districts in the North Carolina congressional map or any of my simulated maps and you look at that perimeter and you measure its length. You then ask the following kind of hypothetical geometric question: If you took that same perimeter -- and

let's just say -- hypothetically say that perimeter is 20. Now draw a circle that has a circumference of 20. What's the area of that circle?

Now, the reason I ask you that hypothetical geometric question is the Popper-Polsby measure is simply a ratio. It is a ratio of the area of the actual district that we started with -- the area of that district to the area of that circle, okay. So that comparison is a ratio that we use in constructing a Popper-Polsby measure.

Now, let me just explain kind of intuitively what that means because I'm not sure the geometric math side is really that important here. It's just a measure of compactness. It's just measuring how efficiently did the boundaries of this district enclose the area of this district. So if you have a district that looks more like a circle or even like a square, then you're going to have a much better, a higher Popper-Polsby score, meaning that you have a more compact district. If you have a district that you say is a really long, thin serpentine-shaped district, then that's really long, thin, narrow. Then you're going to have a worse Popper-Polsby score. So that's the basic idea.

Q All right. There's another compactness test called Reock, is that correct?

A Yes, sir.

Q Does it measure something different than Popper-Polsby?

A Yes, sir. It's a little bit different in how you calculate it geometrically and I would be happy to give you the same explanation for that, if you'd like.
Q Sure. But do they measure compactness in different ways?
A They're slightly different in how they measure compactness. Yes, sir, they are.
Q Is it true that sometimes these compactness tests conflict with each other?
A I think what you mean is that they're going to be slightly different numerically. I wouldn't say they conflict, and there's a good illustration of that all up and down my report. Every time -- if you remember from earlier today when we looked at a comparison of the SB2 Plan to 1,000 simulations in terms of compactness scores, both Reock and Popper-Polsby, we saw the following theme: The SB2 Plan is worse on Reock compactness than all 1,000 simulations and the SB2 Plan is worse on Popper-Polsby in all 1,000 simulations.

Why? Because they're very correlated. They're essentially telling us different aspects of compactness. But districts that -- when you look at them visually, you can tell that they're visually compact. Those kinds of districts tend to score very high on both Popper-Polsby and Reock. That's why we saw both of those measures telling us the same thing about the noncompactness of the SB2 Plan.
Q Is it true your algorithm used Popper-Polsby as a way of

drawing your simulated districts?
A Essentially, yes. I mean, I would be happy to clarify that in some technical detail if you'd like, but that's -- it gets at the right idea even though that's not literally what I did.
Q All right. Is it true that a district that is longer and more rectangular is going to score lower on the Popper-Polsby than other compactness tests?
A Yeah. Like I just said a minute ago, if you have a very long serpentine-shaped district you're going to have a pretty bad Popper-Polsby score in general.
Q All right. So if the 2016 Enacted Plan, even though it contained all whole counties, had a couple districts that were long because it included, you know, four or five counties in a row, that would score lower on Popper-Polsby because it's not more square-like, is that correct?
A It would score not optimally on Popper-Polsby, but let's just be clear here. It also wouldn't score that great on Reock either.
Q But you used Popper-Polsby or some variant of it in your algorithm, correct?
A Yeah, I mean -- and, again, like I said, I would be happy to explain that in some more technical detail because it's not literally what I do, but you're getting at the right idea when you say that. I think you're -- I think that's basically the

right idea.
Q Did you tell your algorithm to prioritize compactness through the Popper-Polsby measure? Is that -- were you telling it to prioritize that as the compactness measure?
A You're talking about -- you're asking whether I prioritized compactness over other Adopted Criteria, is that right?
Q Did you do that?
A Okay. So, yeah, let me explain. The answer is no. And the hierarchy of Adopted Criteria or of nonpartisan criteria in the districting criteria of the districting process is laid out in my reports, and I'm happy to explain that in a little bit of detail here, but you're welcome to stop me if this isn't the sort of answer you're trying to ask for.

So what's really clear in the Adopted Criteria is there are certain viable principles. Obviously, equal population, contiguity, those are the obvious ones, but it's also very specific about county splits and VTD splits. You can only split VTDs to create population equality and in the nonpartisan portion of the Adopted Criteria, you can only split counties to also create equal populations. So that tells me that those two principles are inviable, except to create equal populations. That means, of course, that geographic compactness falls below those two criteria.

So what the algorithm prioritizes is keeping counties

whole and keeping VTDs whole, and only after that do we pay attention to geographic compactness. So I just wanted to answer your question as accurately as I could there by explaining that level of priority.

Q Okay. And the actual criterion itself says that "the Committee shall make reasonable efforts to construct districts...that improve the compactness of the current districts and keep more counties and VTDs whole...."

So are you saying you interpreted that to mean that counties got priority and then compactness after that?

A Well, the reasons that I interpreted that way had to do with, like I said before, what the Adopted Criteria tell us about the reasons acceptable for splitting counties and splitting VTDs. But I think more to your question about compactness, the districts are meant to be compact or the Adopted Criteria tell us to draw compact districts and so that's what I followed in designing my algorithm.

Q All right. Did you pick a Popper-Polsby score that a district had to settle on before it could go into a simulated redistricting plan?

A No, sir. I was agnostic about that issue. I sought to find out what are the sorts of reasonable Popper-Polsby scores that would emerge under a districting plan under a districting process that is making efforts to draw geographically compact districts.

As I said earlier, there are several figures throughout my report that give a clear answer to that. There's a range of compactness scores, both in terms of Reock and Popper-Polsby, that are the product of a reasonable effort to draw geographically compact districts. As I said earlier, the SB2 Plan is completely below, entirely outside of that entire range of all 3,000 simulations.

Q Did you review any literature in your field to determine what others had said a reasonable Popper-Polsby or Reock score would be?

A Yeah, sure. I mean, I'm very familiar with that literature working in the field of redistricting and drawing legislative districts and analysis of districting plans.

Q And so --

A I was just going to give you a more complete answer, but I'm happy to let you cut me off if you'd like.

Q Sure. So you're familiar then with an article written by two gentlemen named Pildes and Niemi about compactness?

A I've seen that article before.

Q Do you recall about that article that they say a low perimeter score or -- would be .05? Do you recall that?

A I couldn't really cite for you that specific -- you know, that specific citation and so -- I mean, if you want to show that to me, I would be happy to kind of affirm for you what they're doing and help you understand what that article is

saying and, more importantly, help you understand what jurisdiction or what districting plan they're analyzing because that's a really important consideration. We want to know if their article with that specific number is actually talking about North Carolina congressional districts, North Carolina legislative districts or, say, Hawaii congressional districts. We need that information to put that in context here.

Q Let me just establish a couple of things. Isn't it true that a perimeter -- a measure of perimeter as a measure of compactness is similar to Popper-Polsby?

A I would try and explain it to you in a slightly different way. If you're comparing two different North Carolina congressional districting plans, here's what you know about those plans: The total area of all 13 districts is going to be the same in both plans because they're going to cover all of North Carolina.

So go back to that Popper-Polsby measure I mentioned and explained in some detail about 10 minutes ago. Now, what does that mean for that formula, for that ratio? It means that the only thing that's going to vary from one districting plan in North Carolina to another North Carolina districting plan is the perimeter of the districts. So that's why if you're comparing two North Carolina congressional districts essentially you are comparing the perimeters.

Of course, you're comparing the perimeters in the

context of that ratio formula that I told you about a while back, but the most important distinction between those plans has to do with the differences in their perimeter because, again, the areas of only North Carolina congressional districting plan, areas across all 13 districts, is going to have the same total area. It's going to be all of North Carolina.

So that's why I think the kind of question you're trying to get at -- you're getting at the right idea, which is that perimeter is what varies from one plan to another.

Q Sure. But all I'm asking is isn't another name for -- the Popper-Polsby test, isn't it a perimeter score for compactness?

A I mean, I haven't heard that kind of shorthand or, you know, nickname for it, but I get what you're getting at even though that's not really what we call it in the scholarly literature.

Q All right. And do you -- are you aware of the Reock measure being called a dispersion compactness score?

A I'm not sure that I've heard that commonly used. I think I know what you're trying to get at, but I'm not sure that's commonly used in the field.

Q All right. Is this Pildes and Niemi article that I've referenced -- let me just make sure I establish you did read that article, correct? You have read that article?

A I've heard of that article before. I mean, I would just

point out to you it was published a long time ago and there's much more current literature talking about district compactness and some of the issues that come up when you're comparing compactness scores from one state to another, one jurisdiction to another. I'm aware that was a paper from, I don't know, about 20, 25, maybe 30 years ago. I just can't remember. So it certainly is one that I have heard of. I couldn't -- I couldn't tell you a whole lot about it off the top of my head, though.

Q All right. Well, let's pull up Exhibit 5041. We'll just take a look at this table in this article and see if this doesn't help you with this.

MR. STRACH: And turn to page 34, Table 3.

BY MR. STRACH:

A Sir, do I get a copy of this article?

Q You'll see it right there on your screen.

A Okay.

Q Do you see on the screen Table 3?

A Yes, sir, I see the top portion of that table.

Q All right. And can you see what the -- tell the Court what the name of that table is.

A It looks like the authors have called this table "1990s Congressional Districts With Low Dispersion Or Perimeter Compactness Scores" and there's a footnote.

Q All right. So they use -- in that table, they use the

dispersion and perimeter nomenclature. Are you saying you're not familiar with that nomenclature?
A I don't hear it very commonly. Again, I would point out for you this is a 1993 article. The field of studying geographic compactness in districts has changed quite a bit since then. We've updated our measures and our understanding of how these various measures work when you're trying to compare districts across very different states. Scholars have pointed out lots of caveats when you're comparing scores across different states. I just want to help you understand it in that context, that this is a very old article.
Q All right. So I take it you didn't use the information in this article in generating your compactness measures that you would use for your simulated sets?
A I didn't go back and specifically look for this article in the production of my report, no, sir.
Q All right. Did you rely on any of the literature on compactness, even that which is more recent, in determining where to set your Popper-Polsby settings?
A I don't know that it was necessary for me to go and specifically find any particular article. Generally I keep up with the field in legislative districting or in redistricting as it's practiced in political science, so certainly these are things that we talk about very frequently with other scholars at conferences, at seminars. So that's how I keep up with the

field and understand what other people are doing.

But I didn't go back and need to consult any particular article simply because the calculation of a Reock score and the calculation of a Popper-Polsby score are such standard measures -- we do them all the time -- that it wasn't something that I needed to go back and refresh my memory about or to find out how to go about calculating these things. They're very commonly done.

Q All right. Well, is it fair to say, as relates to the Popper-Polsby aspect of your analysis, that you were trying to have your algorithm draw districts that would maximize those scores?

A I would say that the algorithm was trying to make reasonable attempts to draw geographic compactness but within some very important constraints, as I've laid out.

So just to be clear and because I think this is what you're asking me to literally tell you with your question, we are not maximizing in this algorithm geographic compactness above other considerations. The Adopted Criteria are very clear about this. There are other considerations in districting that are more important than that and so I just wanted to, at the risk of repetition, make sure you really understand that point because it's so important.

Q Okay. When you did the compactness analysis with the Popper-Polsby, you did that based on a statewide average,

didn't you?
A I calculate the Reock or the Popper-Polsby measure across all 13 districts and then I average them. That's just the standard way of describing the compactness of an entire districting plan with 13 districts.
Q All right. But did you compare any of the specific districts in any of your simulation plans against any of the specific districts in the 2016 Plan as it related to compactness scores?
A The Adopted Criteria didn't tell me to do that and so I definitely would not have done so. And what I mean by that answer is that the Adopted Criteria do not say a sort of compact district is acceptable in western North Carolina, but you want a really compact district in eastern North Carolina. There are no regional decisions like that, so I definitely would not have done such an analysis.
Q So you can't identify any specific district in the 2016 Plan that has a lower Popper-Polsby or Reock score than any comparable district in your simulation plans?
A Again, we're not doing a comparable district analysis because that is not what's laid out in the Adopted Criteria. The Adopted Criteria is not telling us that one threshold for compactness is okay here and it's okay to not draw very compact districts in the northeastern portion of North Carolina or anything like that. There are no regional distinctions when it

comes to compactness. You're supposed to make districts geographically compact.
Q Isn't it possible, though, that there are districts in the 2016 Plan that have higher Popper-Polsby and Reock scores than individual districts in your simulated plans?
A Oh, that's very possible and that's not really relevant to the main issue here, which is that when we analyze districting plans we look at the plan as a whole and we look at the compactness of all the districts together. We don't just say was there one good compact district here and that somehow outweighs a noncompact district in another portion of the state. That's why what we do is we look at the compactness of all 13 districts and take the average, and we compare those averages across plans.
Q All right. Let me move to a different topic here. Do you know how many of the incumbents from 2014 in the North Carolina congressional delegation were reelected in 2016?
A I did not analyze that question, sir.
Q All right. Did you know that the only one not reelected was Congresswoman Renee Ellmers, who lost in a primary to George Holding? Were you aware of that?
A Again, that would not have been relevant to what I saw in the Adopted Criteria, so I definitely did not analyze that factor, that question -- or that issue.
Q All right. Were you aware of the -- for the 2016 Plan,

were you aware of the -- aware the residence of Congressman George Holding was placed in the 2016 Plan?
A You're asking me which district of the enacted plan --
Q Right.
A -- he was placed in?
Q Right.
A I can't tell you off the top of my head. I'm sure, as you know by now, I did, obviously, you know, have locations of the incumbents. So I clearly calculated something relating to that fact at some point. I really couldn't tell you off the top of my head.
Q All right. Does it -- do you have any reason to think that he wasn't placed in the 4th Congressional District?
A No, I accept that.
Q Now, when you did your -- two of your simulation sets, you interpreted the incumbency protection simply to be that each -- there would be no pairing of incumbents, is that right?
A That is what I read from the Adopted Criteria, yes, sir, that to avoid the double-bunking or pairing of incumbents, two in one district or three in one district.
Q And then in a different simulation set you tried to account for the fact that there were only 11 nonpaired incumbents, correct, in the actual plan?
A In Simulation Set Three, which I think is what you're alluding to, sir, yes, sir. So what I did specifically was to

require the simulation algorithm to match precisely the Enacted SB2 Plan in terms of its 11 protected incumbents and 13 county splits.

Q All right. In looking at Simulation Set Three, did you do any analysis of the population from the 2014 district for each incumbent that was retained in the 2016 district?

A The Adopted Criteria did not instruct the map drawer to account for that sort of analysis and therefore I did not do so.

Q Okay. And, of course, you did no analysis of whether any of those incumbents could actually win a district that they were placed in in your simulated sets, correct?

A The Adopted Criteria, again, did not ask the map drawer to account for that factor and therefore I did not do so.

Q The criteria actually did do that, correct, because they said under "Partisan Advantage" the Committee would make reasonable efforts to construct districts to maintain the current partisan makeup of North Carolina's congressional delegation. The criteria say, but you just didn't take that into account because it was a partisan criteria, is that correct?

A I guess I thought your previous question was asking whether a specific incumbent would be re-elected. I read the Adopted Criteria as just saying just create ten Republican districts, so that's why I answered your previous question the

way that I did. I see what you're getting at and I acknowledge to you that I, in fact, ignored the political impact part of the Adopted Criteria as it relates to creating intentionally a ten Republican map.

Q All right. So in your study, you read the incumbent protection criteria separately from the partisan advantage criteria?

A If I could just ask you to repeat.

Q In making your analysis, you read the incumbency protection criteria of these criteria separately from the partisan advantage criteria?

A I accounted for them in two different ways. I ignored the partisan requirement of creating a ten Republican map, but the incumbency portion I certainly read as a different sentence and I interpreted it as meaning that efforts should be made to maximize a number of incumbents that are kept in their own respective districts. So I did read them separately and I treated them as such.

Q All right. And when you ran your third simulation set accounting for nonpairing of 11 incumbents, did you rerun a simulation set all over again or did you apply the 11 incumbency criteria to an existing simulation set?

A The former, sir. This was a completely new, independent set of simulations that had no relation to Simulation Sets One and Two, except in so far as beyond intentionally keeping 11

counties split -- sorry -- 13 counties split and 11 incumbents protected. On top of that, I did prioritize the protection of the nonpartisan portions or maximize adherence to the nonpartisan portions of the Adopted Criteria. But to answer your question, it was a completely different set of simulations, so I started the process anew.

Q All right. And I think you mentioned earlier you didn't try to assess the actual political strength of each district when you were measuring the partisan impact of it, correct?

A The Adopted Criteria did not tell the map drawer to assess the political strength and so therefore I did not do so.

Q All right. So you do not know that if a strong Democratic candidate who was well-funded in any of these ten alleged Republican districts were to run, you've not studied whether such a candidate could beat a Republican in one of these districts?

A Again, sir, the Adopted Criteria did not tell me to take into account campaign finance dynamics. Therefore, I did not do so.

MR. STRACH: Could we pull up Exhibit 5043?

JUDGE OSTEEN: How much longer do you anticipate, Mr. Strach?

MR. STRACH: It could be a bit. I think it will be more than 10 minutes.

JUDGE OSTEEN: All right. All right. We'll go

roughly ten more minutes, and then we'll take off, unless you all want to be heard on that. I think that I said court would go until 5:30, but I can't remember.

MR. SPEAS: You did.

JUDGE OSTEEN: Okay. Is that good, ten more minutes?

MR. STRACH: Thank you, Your Honor.

BY MR. STRACH:

Q Dr. Chen, I've got Exhibit 5043, which I believe is just simply a table out of your report. Does that look familiar?

A Yes, sir.

Q All right. And in this exhibit or in this --

A I'm sorry. If I could go back and clarify, sir.

Q Yes.

A You asked me if it came from my report, is that right?

Q Maybe -- is this something you created after your report was submitted?

A That's correct, sir, April 24th.

Q That's right. Okay. And this was discussed with you at your deposition, correct?

A I believe Mr. Farr asked me a bit about this, yes, sir.

Q In this exhibit, you identified the number of your simulated plans that have one district with at least 40 percent BVAP, is that correct?

A Yes, sir, black voting-age population.

Q Okay. So for your Simulated Set No. 1, you had 85 of the

1,000 plans had such a district, is that correct?
A Yes, sir.
Q And in Simulation Set No. 2, you had 119 out of a thousand plans had such a district, correct?
A Yes, sir.
Q And in Simulation Set No. 3, only 58 plans had such a district, is that correct?
A Yes, sir.
Q All right. So out of 3,000 simulated plans, you had a total of 262 that had at least one district with a BVAP of over 40 percent, is that correct?
A That sounds about right, sir, if your math is correct.
Q All right. And that's less than 10 percent, correct?
A That is correct, sir.
Q Now, the 2016 -- are you familiar with the BVAP of the enacted -- any of the enacted districts?
A Of the Enacted 2016 Plan?
Q Yes, sir.
A My answer is that the Adopted Criteria told me to ignore any racial data about districts or about voters in North Carolina, and so I definitely would not have analyzed that number.
Q All right. But nonetheless, even though the criteria didn't address it, you did nonetheless do an analysis of it, correct?

A I was just clarifying that the Adopted Criteria instructed me to ignore it, so the Adopted Criteria did tell me very specifically.
Q Not to use race?
A Correct.
Q But notwithstanding that criteria, you, in fact, did analyze race and you looked at the 40 percent BVAP districts, correct?
A Correct. I did so well after the writing and the production of my expert reports.
Q Right. But you're aware that one of the congressional districts in the 2016 map has a BVAP of over 44 percent. Does that sound correct to you?
A Again, I accept that you've represented that to me, but as I said earlier, I definitely would not have analyzed that myself.
Q And you used in your -- in the exhibit that we're looking at, you used, it looks like, 40 percent as your threshold or your cutoff, is that correct?
A That's correct, sir. I went through all 1,000 simulations -- simulated maps and I identified which ones contained at least one district with a 40 percent black voting-age population.
Q Why did you pick 40 percent rather than, say, 44 percent to reflect the actual plan?

A Plaintiffs' counsel asked me for that calculation, sir.
Q Okay. So this was something -- this was a number that you picked for your analysis based on what a lawyer asked you to do?
A I didn't pick the number. Plaintiffs' counsel asked me for the number of districts or simulated plans containing a district with over 40 percent black voting-age population and I answered that question for Plaintiffs' counsel.
Q Did you ever do an analysis of -- based on searching for districts that had over 44 percent BVAP?
A You're asking me if I analyzed my simulated plans with respect to that number?
Q Yes, sir.
A And the answer is Plaintiffs' counsel did not ask me to do so.
Q Okay. You are aware that the 2016 Enacted Plan has moved the 12th Congressional District to wholly within Mecklenburg County. Are you familiar with that?
A I didn't study the previous plan, but I accept your representation about that fact.
Q And you did not ask your algorithm to require at least one congressional district to be wholly located within Mecklenburg County, did you?
A The Adopted Criteria definitely did not instruct the map drawer to do so. Therefore, I did not do so.

Q You understand that the 2016 Enacted Plan has a second district -- that has one district with 44 percent of BVAP and it has a second district with at least 35 percent BVAP. Were you aware of that?
A I accept your representation of that, but again, I definitely did not analyze that in my report.
Q So did your counsel ask you to search for simulated plans that had both one district of at least 40 percent BVAP and at least one district of 35 percent BVAP?
A Plaintiffs' counsel did not ask me for that number, sir.
Q Do you know whether any of your simulated plans have a district of at least 44 percent BVAP?
A Plaintiffs' counsel did not ask me to do that calculation. I didn't do so, sir.
Q So the answer is you don't know?
A Correct, sir. I don't know because I was -- I definitely would have in my report ignored race.
Q What was the significance of you picking or having a thousand simulated maps in each set? What was the significance of a thousand or was there any significance?
A The significance is that it is a number of simulated plans that allows us to be able to draw strong statistical conclusions from the body of simulations of simulated maps as compared to an enacted map. So it is a number that goes far beyond what we actually need in order to draw conclusions about

the extent to which, for example, the Enacted SB2 Plan is an extreme partisan outlier compared to the simulated maps or the extent to which the SB2 Plan does as well as it reasonably could have in complying with the nonpartisan portions of the Adopted Criteria. So it is a large enough number that we are well beyond what is necessary to have strong, statistically significant conclusions regarding these questions.

Q And how low can you go before you lack the strong statistical significance in the results?

A What do you mean how low you can go, sir? You're asking how many simulated plans?

Q Yeah, below a thousand.

A Oh, how many below 1,000. Well, I certainly conducted my academic research analysis of districting plans in different states based upon as few as 25 simulated plans in my past academic research, but what we do here, especially when I produce an expert report, is I want to be extraordinarily conservative in reaching any conclusions. I'm reaching conclusions and so what I do is essentially overkill. I draw an extremely large number of plans in order to make sure that I am showing extraordinary deference to, say, an enacted plan that I'm analyzing. I want to make sure if I'm drawing any conclusions at all that I'm extremely statistically certain about them. That's why I don't stop at, say, 25, even though I've done so in my past academic research.

JUDGE OSTEEN: Are you ready?

MR. STRACH: I've got more, but, yeah, I'll stop whenever you're ready.

JUDGE OSTEEN: All right. We'll stand in recess until tomorrow morning at 9:00.

(At 5:27 p.m., proceedings adjourned.)

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C E R T I F I C A T E

I certify that the foregoing is a correct transcript from the proceedings in the above-entitled matter.

Date: 10/23/2017

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